# BSAI crab stocks Management and Assessment

Robert Foy

2015 GMACS/Bristol Bay red king crab stock CIE Review

June 28, 2015

NOAA FISHERIES
Alaska Fisheries Science Center

# Overview

- Management
  - FMP
  - TAC: ADF&G harvest strategy
- NPFMC Status of Stocks
  - OFL & ABC: Tier System
- Stock Assessment
  - Survey
  - Additional considerations

# BSAI Crab Management Overview

# Fishery Management Plan (FMP) for the BSAI King and Tanner Crabs

- State/Federal cooperative management regime
  - Crab management deferred to State
  - Federal oversight

# 10 Crab stocks under the FMP

- Bristol Bay red king crab
- EBS snow crab
- EBS Tanner crab
- Aleutian Island golden king crab
- Pribilof Island red king crab *
- Pribilof Island blue king crab*
- St. Matthew blue king crab
- Norton Sound red king crab
- Pribilof Island golden king crab *
- Adak red king crab *

All Target stocks, some (*) currently closed

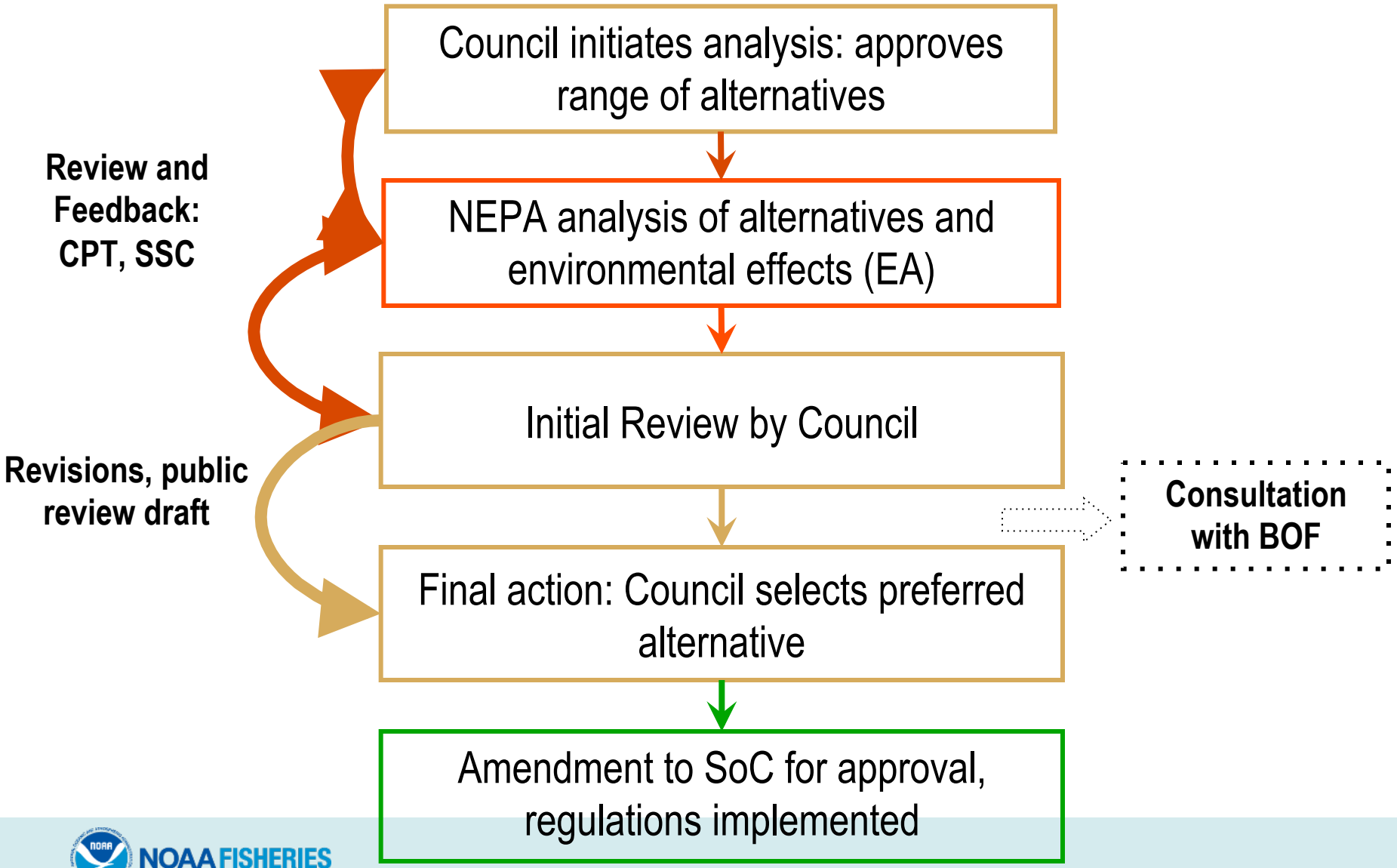
# Management measures under FMP

- 3 categories of management measures defined under the FMP
  - Category 1: Fixed.
    - FMP amendment to change (compliance with Fed law e.g. MSA)
  - Category 2: Frameworked.
    - State has flexibility within the criteria specified for frameworked measures (e.g. TAC)
  - Category 3: Discretionary.
    - State can change through own process (e.g. gear modifications)

# Management measures under FMP

| **Category 1** (Fixed in FMP) | **Category 2** (Frameworked in FMP) | **Category 3** (Discretion of State) |
|---|---|---|
| · Legal Gear<br>· Permit Requirements<br>· Federal Observer Requirements<br>· Limited Access (CRP)<br>· Norton Sound Superexclusive Registration Area<br>· Essential Fish Habitat<br>· Habitat Areas of Particular Concern | · Minimum Size Limits<br>· TACs/GHLs<br>· Inseason Adjustments<br>· Districts, Subdistricts and Sections<br>· Fishing Seasons<br>· Sex Restrictions<br>· Closed Waters<br>· Pot Limits<br>· Registration Areas | · Reporting Requirements<br>· Gear Placement and Removal<br>· Gear Storage<br>· Gear Modifications<br>· Vessel Tank Inspections<br>· State Observer Requirements<br>· Bycatch Limits (in crab fisheries)<br>· Other |

# Process for FMP amendment



# Overfished and overfishing

- Catch from all sources considered
- If fishery is overfished or overfishing is occurring:
  - SoC must notify the Council.
  - Council must take action within 2 years of notification to prepare FMP amendment for purposes of ending overfishing and rebuilding stock.

# Annual Biological Catch (ABC) specification

- Control rules which account for uncertainty
- Process for recommendations (CPT and SSC)
- accountability measures (AMs) if ACL (ABC) exceeded

# Bristol Bay Red King Crab State Harvest Strategy

- **Stock threshold for opening fishery:**
  - 8.4-million mature-sized females (females ≥ 90 mm CL), and
  - 14.5-mill lb of effective spawning biomass (ESB)
- **Exploitation rate on mature-sized (≥120-mm CL) male abundance:**
  - 10%, when ESB <34.75-mill lb
  - 12.5%, when ESB is between 34.75-mill lb and 55.0-mill lb
  - 15%, when ESB ≥55.0-mill lb
- **Harvest capped at 50% of legal male abundance**

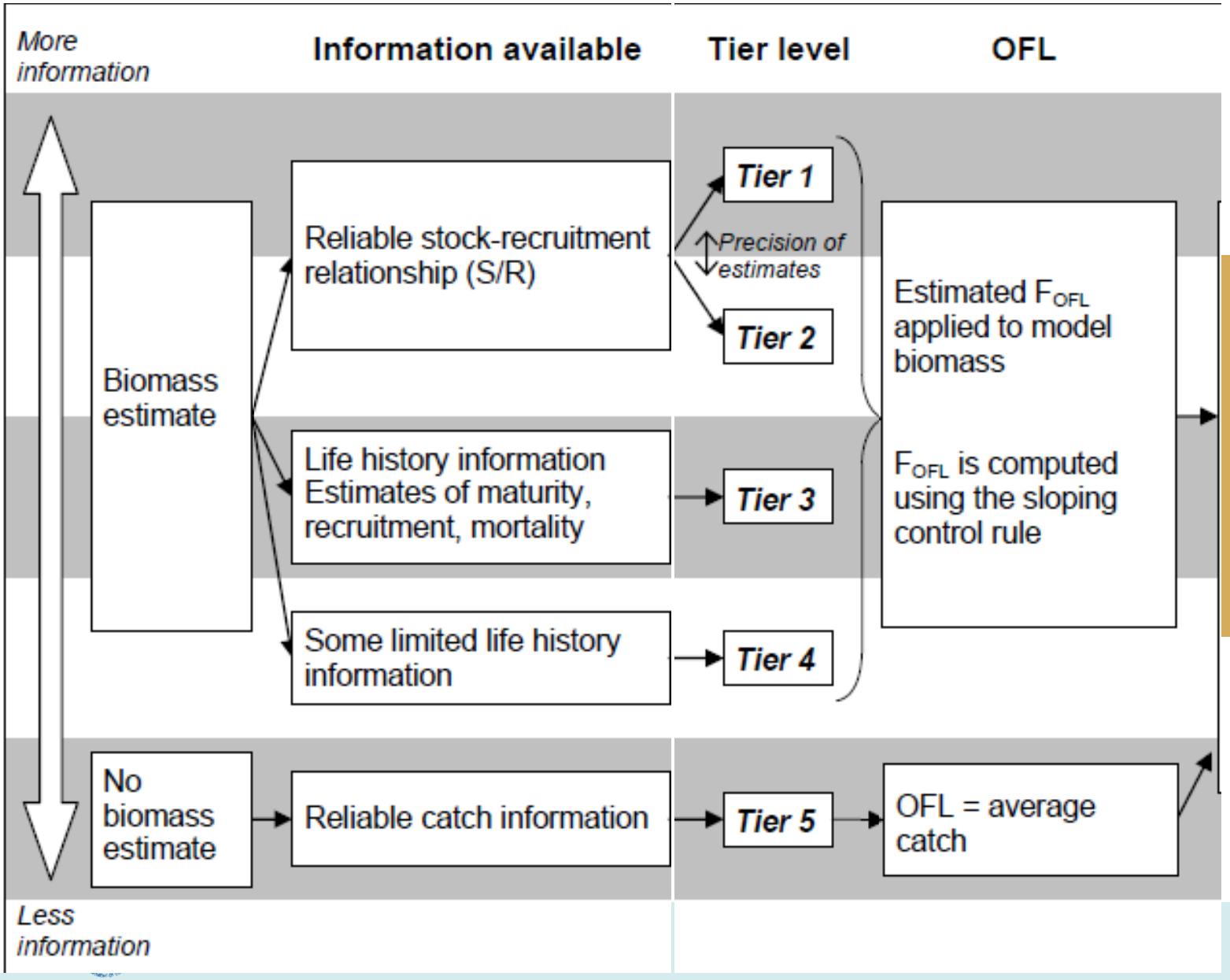
If estimated abundance of mature-sized females ≥ 8.4-million crab, TAC computed by:

| ESB Range (millions of pounds) | TAC Computation | 50% Legal Cap[a] |
|---|---|---|
| <14.5 | 0 | 0 |
| ≥14.5, but <34.75 | 0.1•M•W | 0.5•L•W |
| ≥34.75, but < 55.0 | 0.125•M•W | 0.5•L•W |
| ≥55.0 | 0.15•M•W | 0.5•L•W |

- ESB = effective spawning biomass
- M = mature-sized male (males ≥ 120 mm CL) abundance
- L = legal male (males ≥ 135 mm CL) abundance
- W = expected average weight of landed legal males

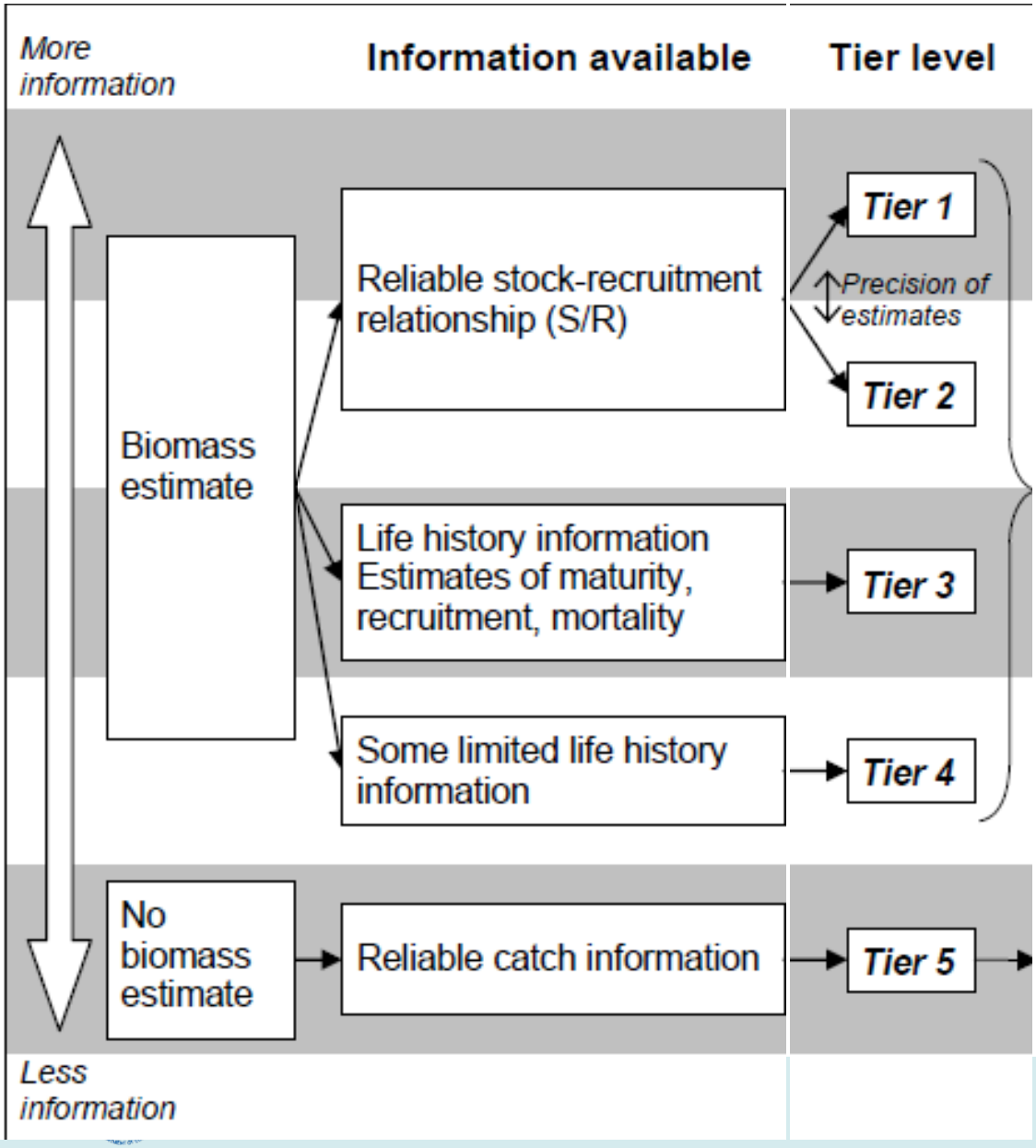
# BSAI Crab Biological Reference Points and Status of Stocks

# Current Crab Management Tier System




ACL =% Buffer

# Current Crab Management Tier system



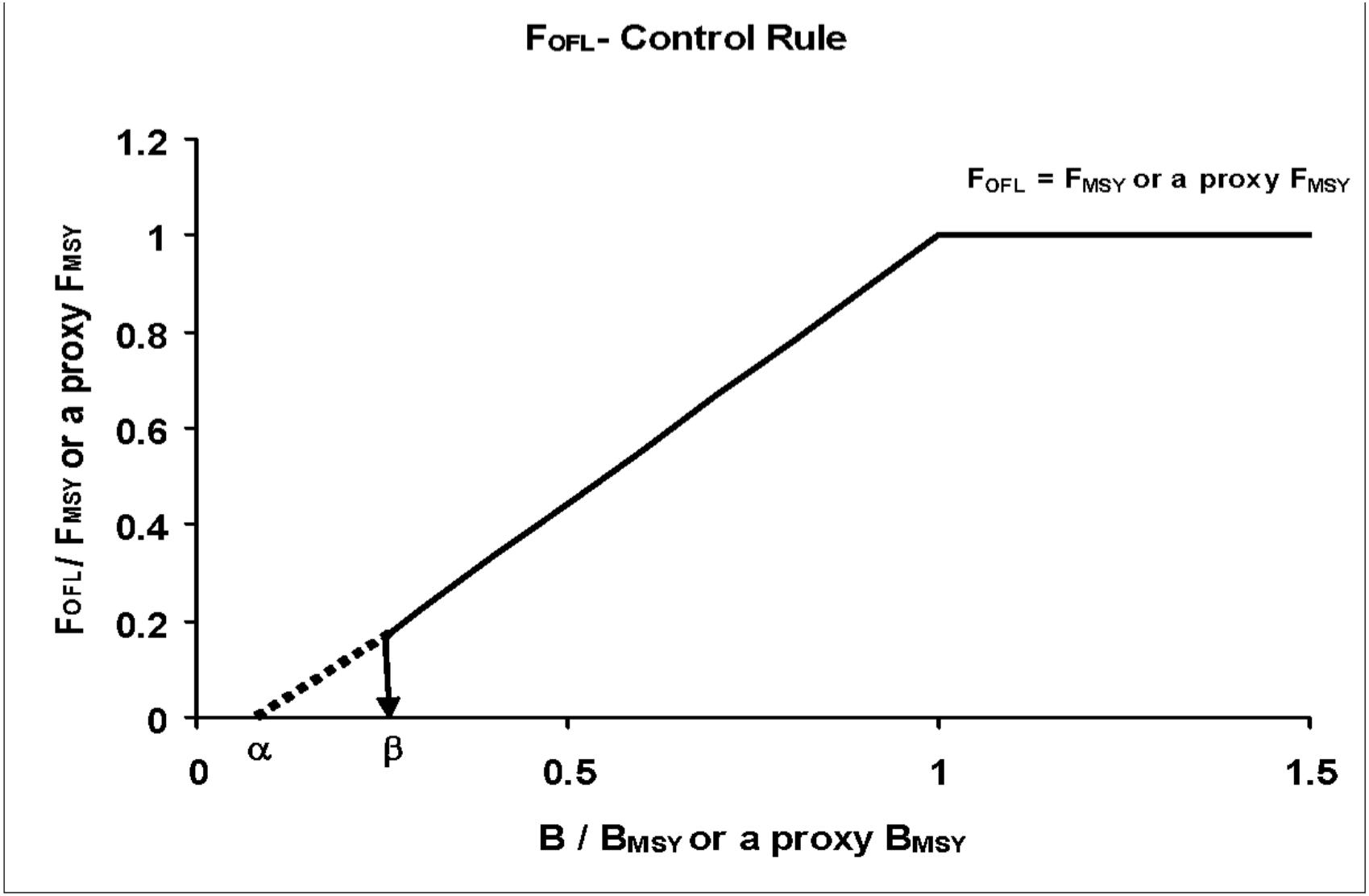

STOCKS

Snow crab
Bristol Bay Red king crab

Tanner Crab
St. Matthew Blue King Crab
Pribilof Islands Red King Crab
Pribilof Islands Blue King Crab
Norton Sound Red King Crab

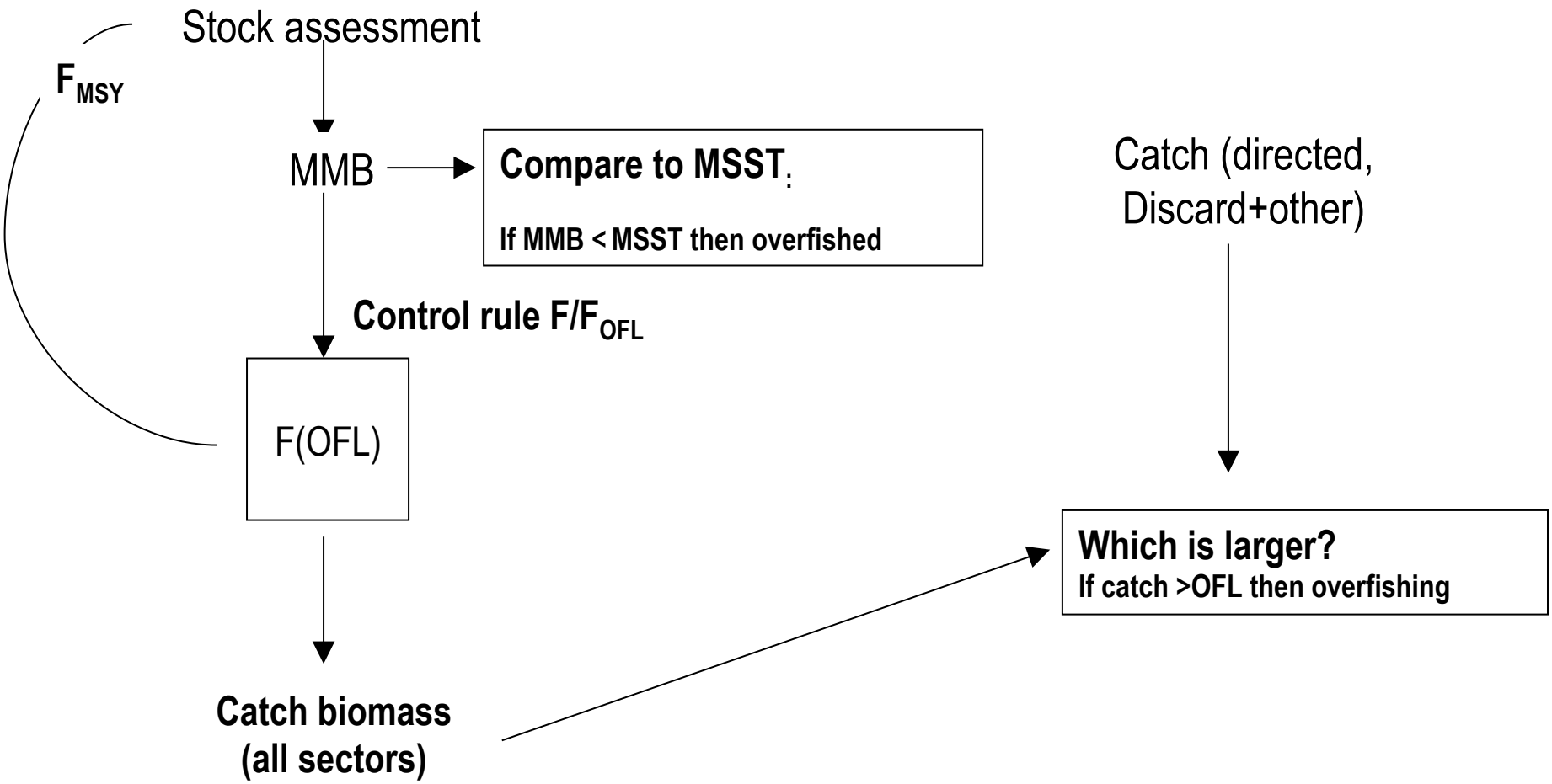
Aleutian Islands Golden King Crab
Pribilof Islands Golden King Crab
Adak Red King Crab

| Information available | Tier | Stock status level | $F_{OFL}$ | ABC control rule |
|---|---|---|---|---|
| $B$, $B_{MSY}$, $F_{MSY}$, and pdf of $F_{MSY}$ | 1 | a. $\frac{B}{B_{msy}} > 1$ | $F_{OFL} = \mu_A$ = arithmetic mean of the pdf | |
| | | b. $\beta < \frac{B}{B_{msy}} \leq 1$ | $F_{OFL} = \mu_A \frac{B/B_{msy} - \alpha}{1-\alpha}$ | ABC≤(1-$b_y$) * OFL |
| | | c. $\frac{B}{B_{msy}} \leq \beta$ | Directed fishery F = 0<br>$F_{OFL} \leq F_{MSY}$† | |
| $B$, $B_{MSY}$, $F_{MSY}$ | 2 | a. $\frac{B}{B_{msy}} > 1$ | $F_{OFL} = F_{msy}$ | |
| | | b. $\beta < \frac{B}{B_{msy}} \leq 1$ | $F_{OFL} = F_{msy} \frac{B/B_{msy} - \alpha}{1-\alpha}$ | ABC≤(1-$b_y$) * OFL |
| | | c. $\frac{B}{B_{msy}} \leq \beta$ | Directed fishery F = 0<br>$F_{OFL} \leq F_{MSY}$† | |
| $B$, $F_{35\%}$*, $B_{35\%}$* | 3 | a. $\frac{B}{B_{35\%}*} > 1$ | $F_{OFL} = F_{35\%}*$ | |
| | | b. $\beta < \frac{B}{B_{35\%}*} \leq 1$ | $F_{OFL} = F^*_{35\%} \frac{\frac{B}{B^*_{35\%}} - \alpha}{1-\alpha}$ | ABC≤(1-$b_y$) * OFL |
| | | c. $\frac{B}{B_{35\%}*} \leq \beta$ | Directed fishery F = 0<br>$F_{OFL} \leq F_{MSY}$† | |
| $B$, $M$, $B_{msy\,prox}$ | 4 | a. $\frac{B}{B_{msy\,prox}} > 1$ | $F_{OFL} = \gamma M$ | |
| | | b. $\beta < \frac{B}{B_{msy\,prox}} \leq 1$ | $F_{OFL} = \gamma M \frac{B/B_{msy\,prox} - \alpha}{1-\alpha}$ | ABC≤(1-$b_y$) * OFL |
| | | c. $\frac{B}{B_{msy\,prox}} \leq \beta$ | Directed fishery F = 0<br>$F_{OFL} \leq F_{MSY}$† | |


FOFL- Control Rule
FOFL = FMSY or a proxy FMSY
FOFL/ FMSY or a proxy FMSY
1.2
1
0.8
0.6
0.4
0.2
0
α
β
0
0.5
1
1.5
B / BMSY or a proxy BMSY

**Fall 2015:**
Determination of OFL, MSST and stock status (for 15/16)

**Fall 2016:**
Determination of overfishing (15/16)



# OFL-setting process

- Annual assessments for all 10 stocks
- Spring review: CPT (May) and SSC (June)
  - Draft assessment models, other data
  - Tier level and model parameter recommendations
- Fall review: CPT (September) SSC (October)
  - Final assessments, final SAFE report
  - OFL review by CPT in Sept and SSC/Council in October
  - Stock status determination:
    - Overfished (biomass-based determination)
    - Overfishing (previous year's catch compared to OFL)

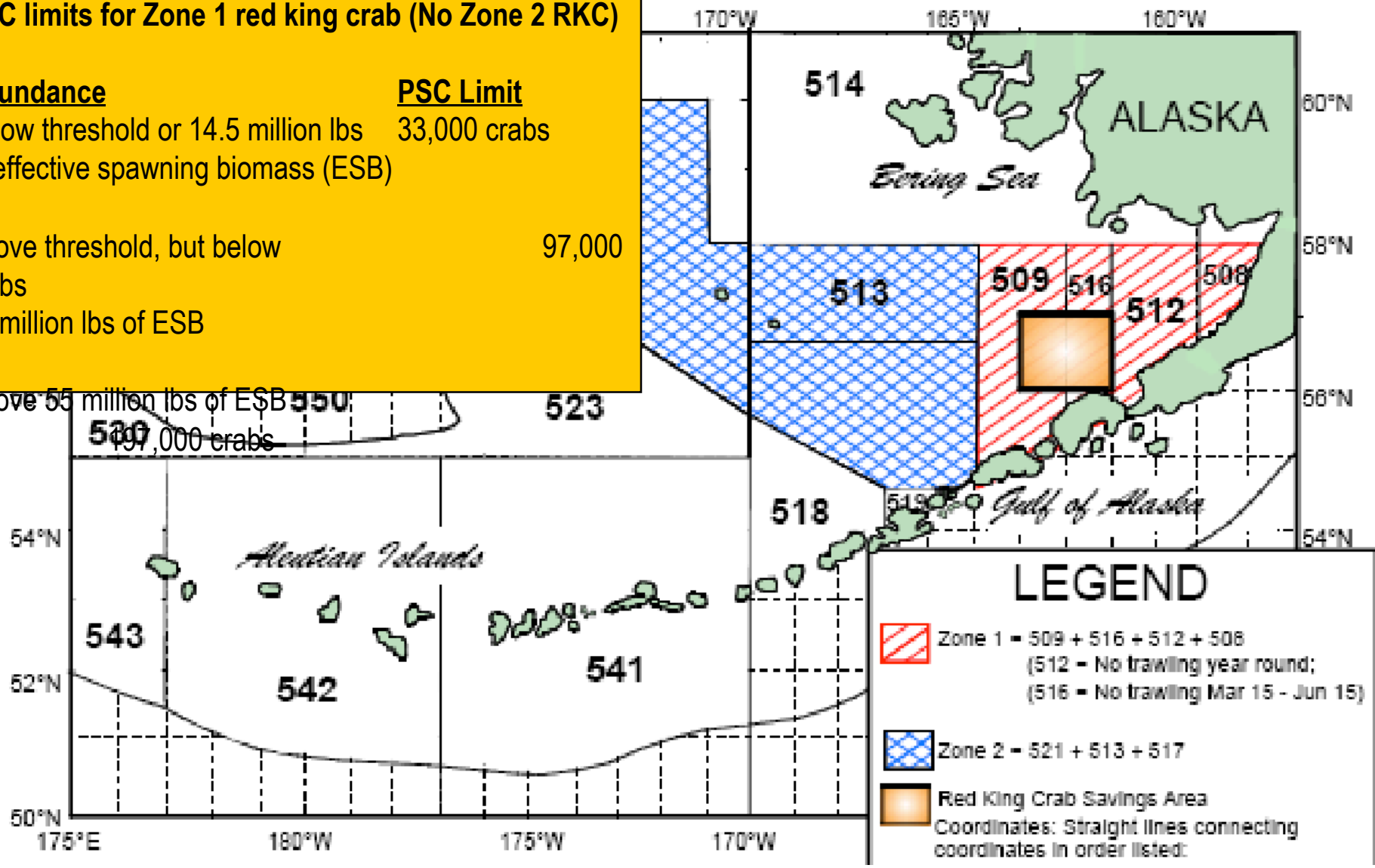
# Bycatch of BBRKC in other fisheries

- Bycatch limits in groundfish and scallop fisheries
  - No feedback mechanism for catch limits in other FMPs
  - Currently any catch constraint due to bycatch in other fisheries will be borne solely by crab fishery
- Scallop:
  - Fixed limits (Bering Sea 500 crabs)
  - Bycatch of RKC <10 crab/yr last 10 years
- Groundfish:
  - Time area closures for trawl fisheries (only)
  - Other fixed area closures for BBRKC

# Bycatch of BBRKC in groundfish fisheries

**PSC limits for Zone 1 red king crab (No Zone 2 RKC)**

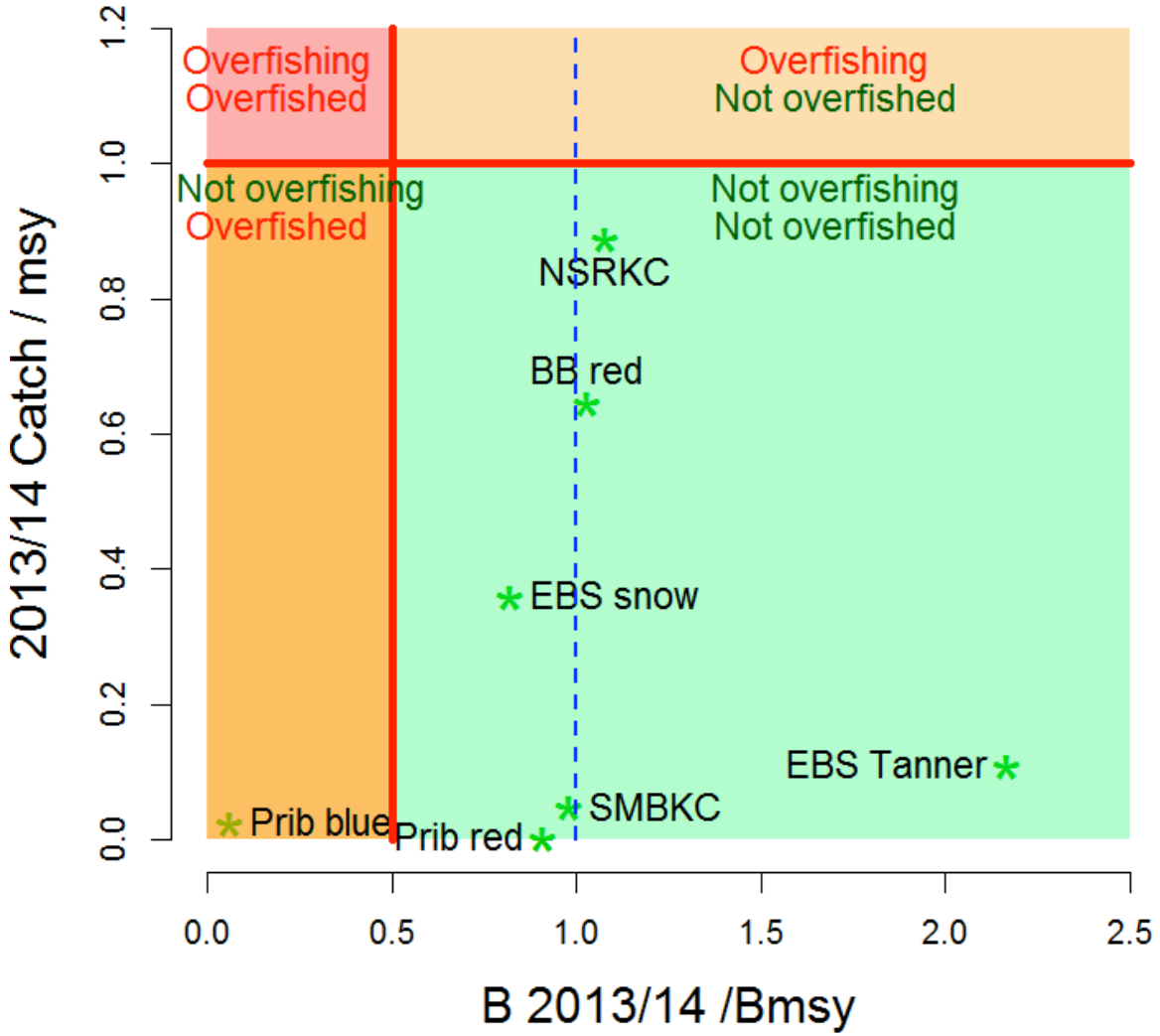
| **Abundance** | **PSC Limit** |
|---|---|
| Below threshold or 14.5 million lbs of effective spawning biomass (ESB) | 33,000 crabs |
| Above threshold, but below 55 million lbs of ESB | 97,000 crabs |
| Above 55 million lbs of ESB | 197,000 crabs |



| Stock | Tier | Status (a,b,c) | $F_{OFL}$ | $B_{MSY}$ or $B_{MSYproxy}$ | 2014/15 MMB | 2014 MMB / $MMB_{MSY}$ | 2014/15 OFL | 2014/15 ABC | ABC buffer (%) |
|---|---|---|---|---|---|---|---|---|---|
| EBS snow crab | 3 | b | 1.34 | 142.9 | 137.6 | 0.96 | 69.0 | 62.1 | 10% |
| BB red king crab | 3 | b | 0.28 | 25.7 | 24.69 | 0.96 | 6.82 | 6.14 | 10% |
| EBS Tanner crab | 3 | a | 0.61 | 29.82 | 63.8 | 2.14 | 31.48 | 25.18 | 20% |
| Pribilof Islands red king crab | 4 | b | 0.18 | 2.75 | 2.24 | 0.81 | 0.32 | 0.27 | 15% |
| Pribilof Islands blue king crab | 4 | c | 0 | 4.00 | 0.22 | 0.05 | 0.00116 | 0.00087 | 25% |
| St. Matthew Island blue king crab | 4 | b | 0.18 | 7.78 | 3.04 | 0.86 | 0.43 [total male catch] | 0.34 [total male catch] | 20% |
| Norton Sound red king crab | 4 | b | 0.157 | 1.9 | 1.68 | 0.88 | 0.21 | 0.19 | 10% |
| Aleutian Islands golden king crab | 5 | | | | | | 5.69 | 4.26 | 25% |
| Pribilof Islands golden king crab | 5 | | | | | | 0.09 | 0.07 | 25% |
| Adak red king crab | 5 | | | | | | 0.05 | 0.03 | 40% |

| Stock | Tier | MSST | $B_{MSY}$ or $B_{MSYproxy}$ | 2013/14 MMB | 2013/14 MMB / $MMB_{MSY}$ | 2013/14 OFL 1000 t | 2013/14 Total catch |
|---|---|---|---|---|---|---|---|
| EBS snow crab | 3 | 71.50 | 143.00 | 126.50 | 0.88 | 78.1 | 28.1 |
| BB red king crab | 3 | 12.85 | 25.70 | 27.12 | 1.06 | 7.07 | 4.56 |
| EBS Tanner crab | 3 | 16.98 | 33.96 | 72.70 | 2.14 | 25.35 | 2.78 |
| Pribilof Islands red king crab | 4 | 2.58 | 5.16 | 4.68 | 0.91 | 0.90 | 0.0023 |
| Pribilof Islands blue king crab | 4 | 2.00 | 4.00 | 0.28 | 0.07 | 0.00116 | 0.00003 |
| St. Matthew Island blue king crab | 4 | 1.55 | 3.1 | 3.04 | 0.98 | 0.56 [total male catch] | 0.027 [total male catch] |
| Norton Sound red king crab | 4 | 1.0 | 2.0 | 2.16 | 1.08 | 0.18 [total male] | 0.16 |
| Aleutian Islands golden king crab | 5 | | | | | 5.69 | 3.19 |
| Pribilof Islands golden king crab | 5 | | | | | 0.09 | Conf. |
| Adak red king crab | 5 | | | | | 0.054 | 0.001 |

# Bering Sea Crab Stocks



# NPFMC-GMACS-Why?

- 2009: Bering Sea crab industry led effort to consider generic model
  - To standardize models across stocks
  - Increase transparency
- 2012: Maunder report: "Generic stock assessment model for Alaskan crab stocks."
- 2013-2015: UW and AFSC collaboration: Jim Ianelli, Steve Martell, Athol Whitten
  - Consider future development
  - Consider multiple author, multiple agency collaboration
  - Expand to all crab stocks

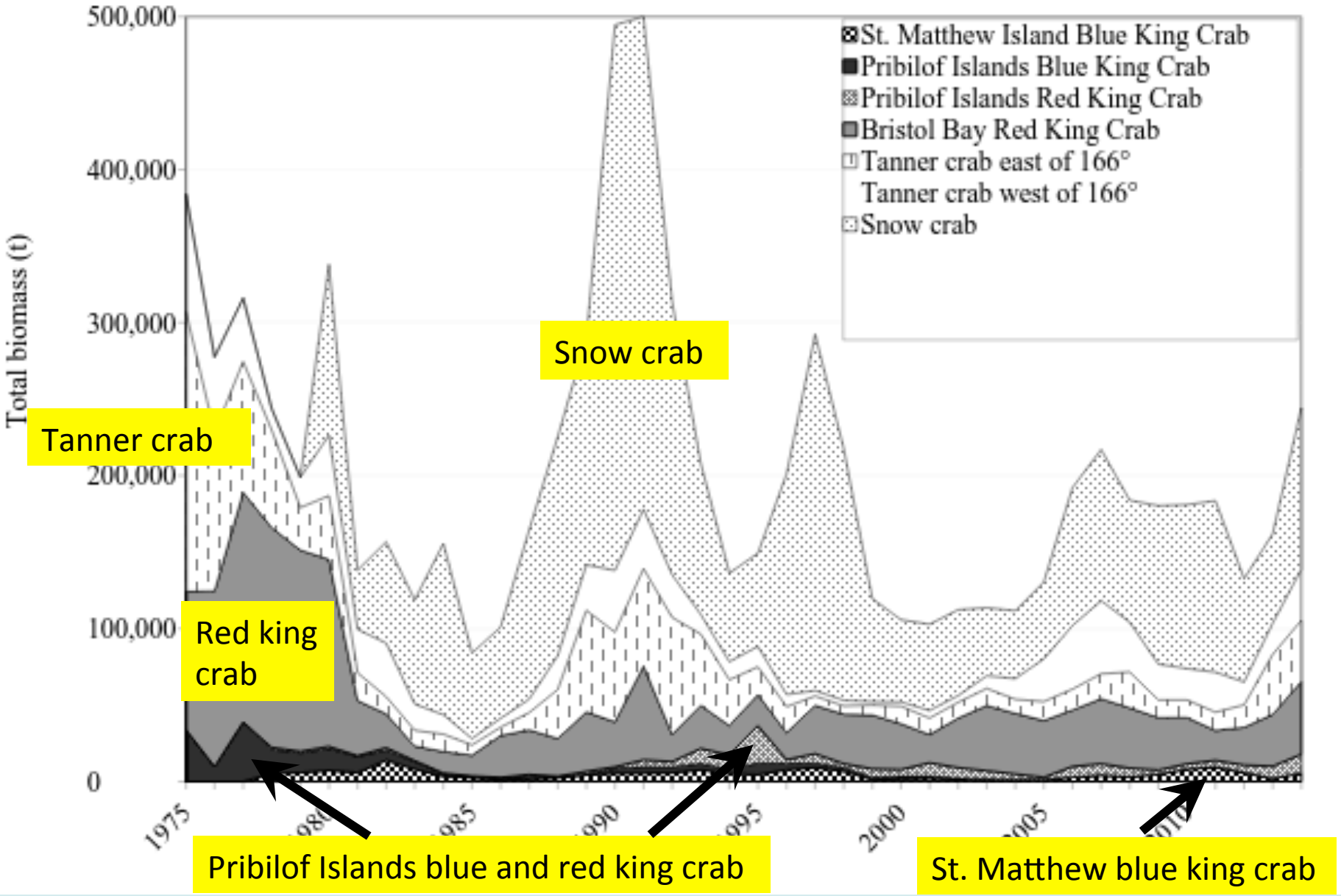
Crab Plan Team:

# NPFMC-GMACS-Why?

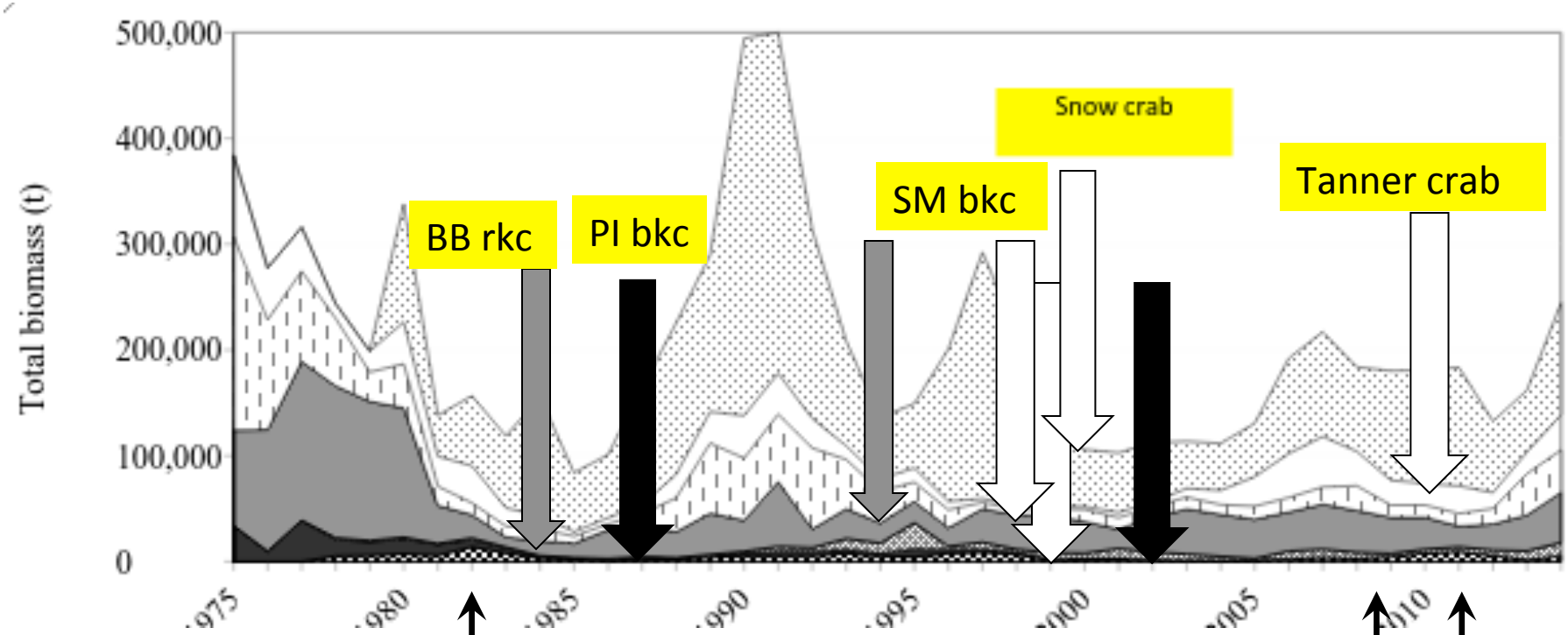
Crab Plan Team:

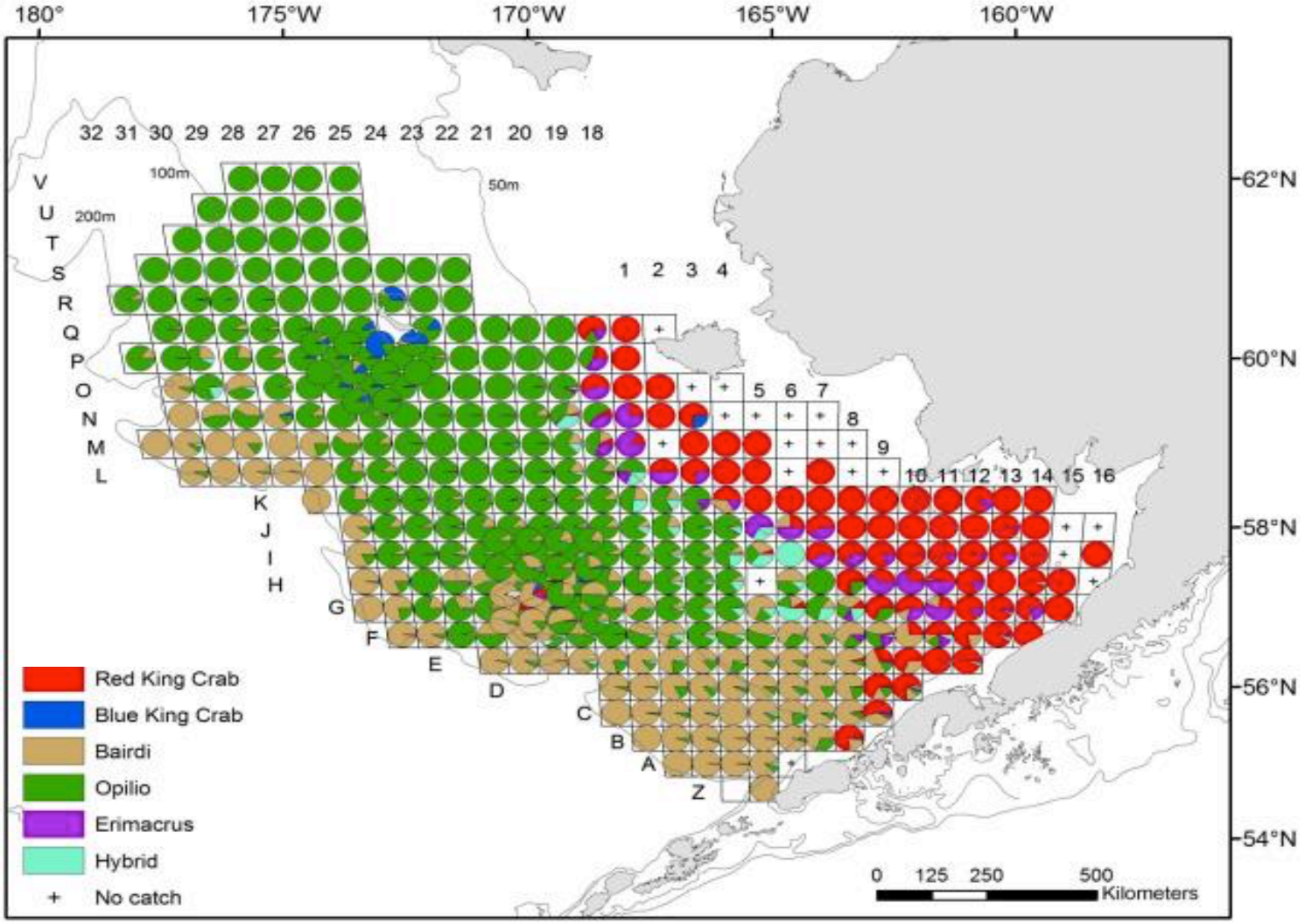
- Feedback on the multi-authorship framework which is necessary given the co-management and involvement of industry (i.e. transparency necessary)
- What is the feasibility of expanding the model to multiple crab stocks given the life history complexities?
- What is a reasonable timeline for BB red king crab?

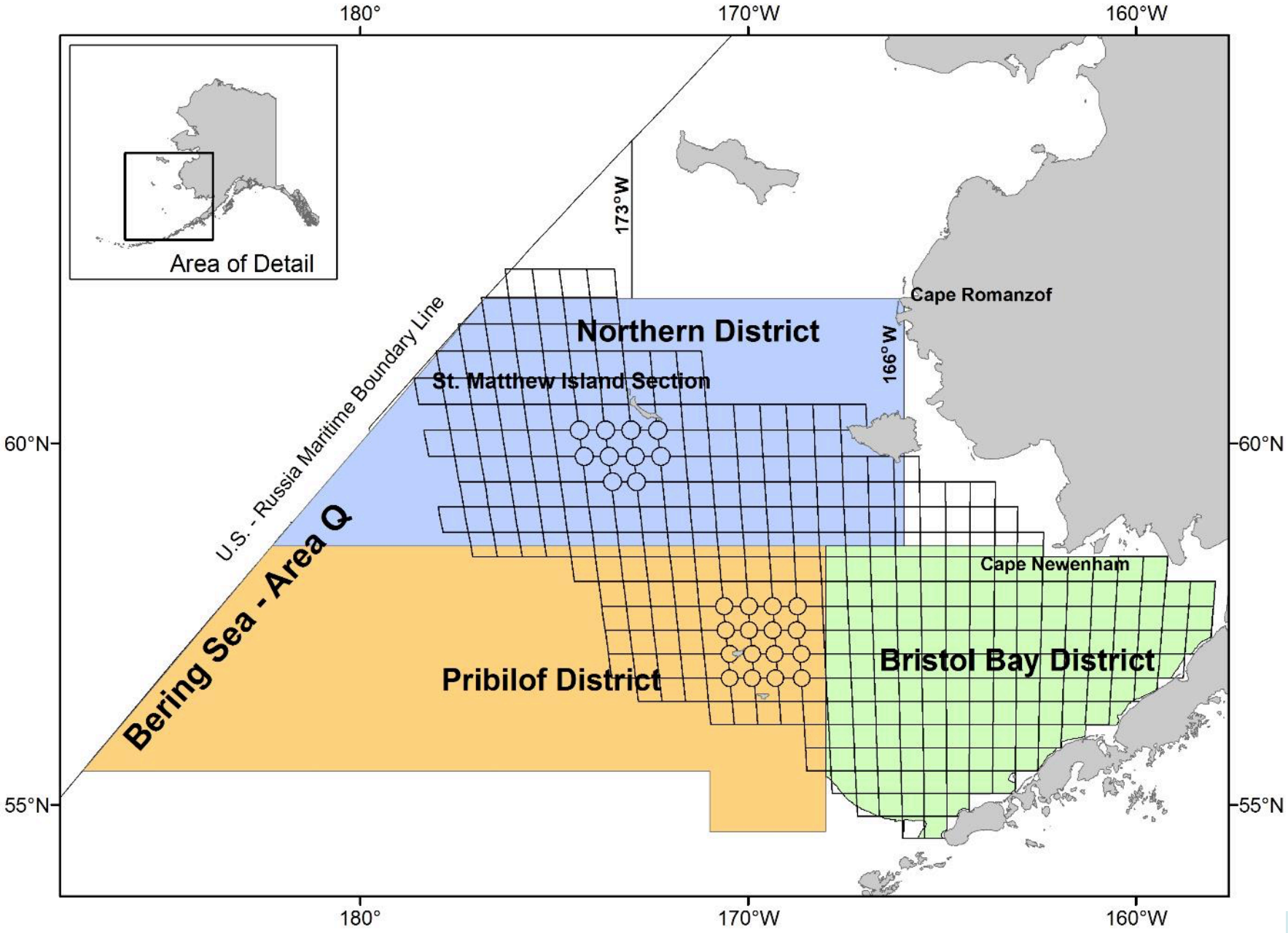
# EBS Bottom Trawl Survey Time Series
# Bristol Bay Red King Crab


500,000
400,000
300,000
200,000
100,000
0
Total biomass (t)
St. Matthew Island Blue King Crab
Pribilof Islands Blue King Crab
Pribilof Islands Red King Crab
Bristol Bay Red King Crab
Tanner crab east of 166°
Tanner crab west of 166°
Snow crab
1975
2000
Snow crab
Tanner crab
Red king crab
Pribilof Islands blue and red king crab
St. Matthew blue king crab

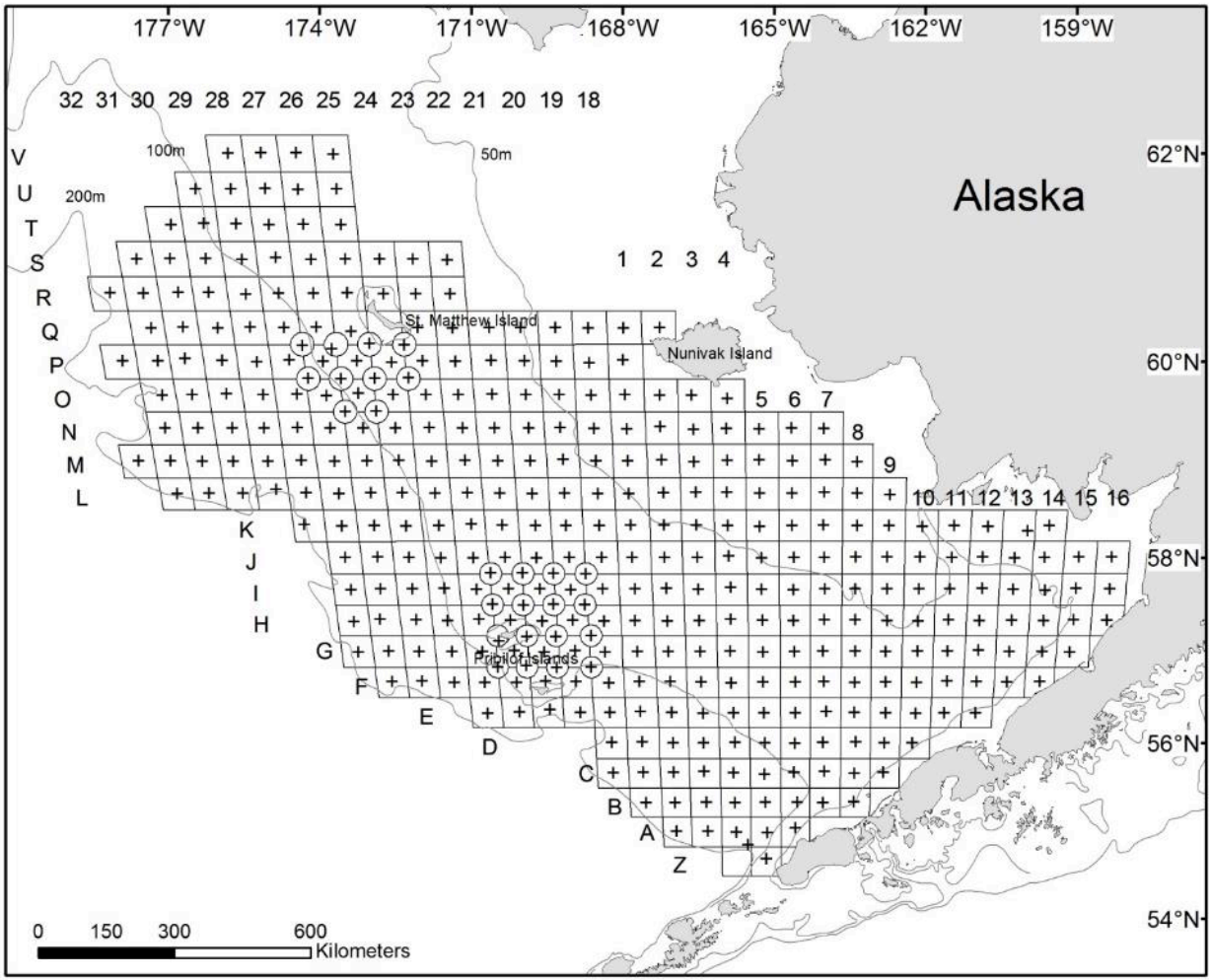
# Historical closures/overfished declarations




180°
175°W
170°W
165°W
160°W
62°N
60°N
58°N
56°N
54°N
32 31 30 29 28 27 26 25 24 23 22 21 20 19 18
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
V U T S R Q P O N M L
K J I H G F E D C B A Z
100m
200m
50m
Red King Crab
Blue King Crab
Bairdi
Opilio
Erimacrus
Hybrid
No catch
0 125 250 500
Kilometers

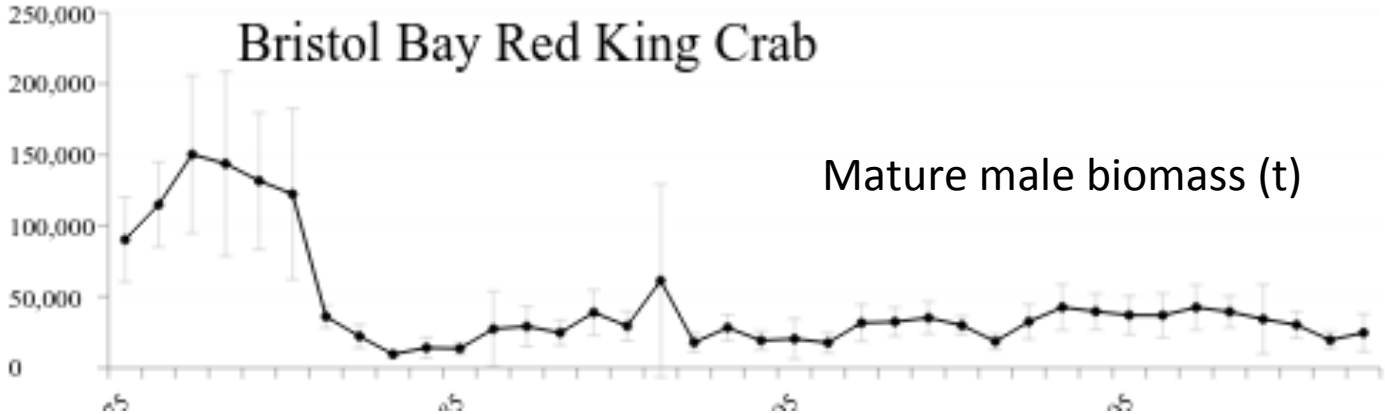

180°
170°W
160°W
Area of Detail
173°W
166°W
Cape Romanzof
Northern District
St. Matthew Island Section
U.S. - Russia Maritime Boundary Line
60°N
Bering Sea - Area Q
Cape Newenham
Bristol Bay District
Pribilof District
55°N
180°
170°W
160°W

# 2014 standard Bering Sea survey

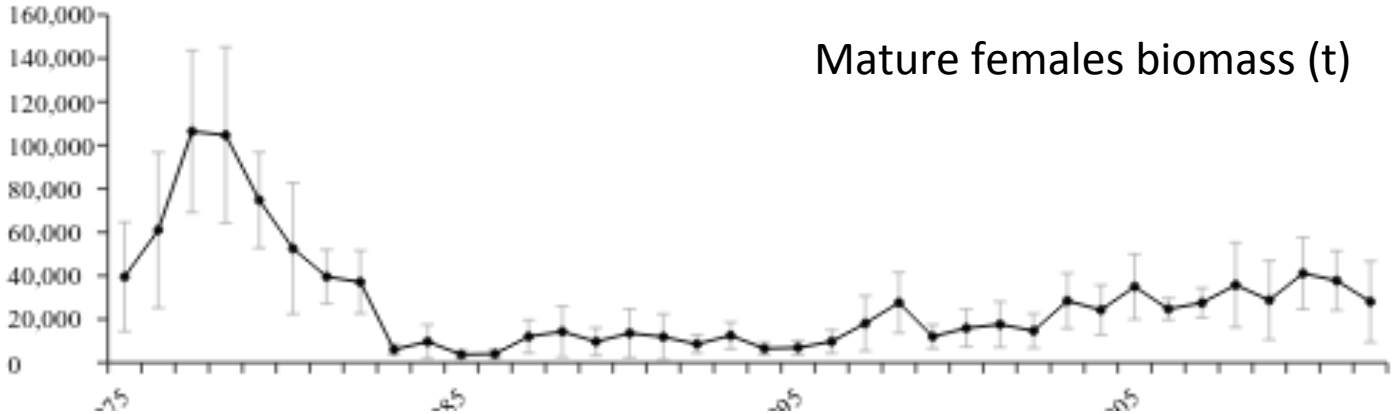



## HIGHLIGHTS

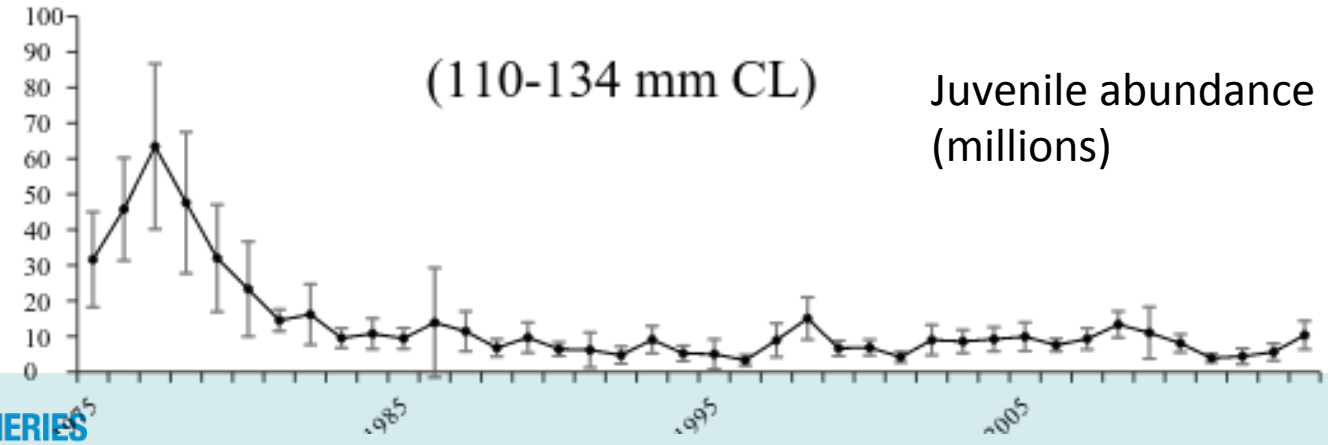
- June 8 – 2 Aug
- 376 standard stations
- 140,350 $nm^2$
- 10 special crab projects




Mature male biomass (t)

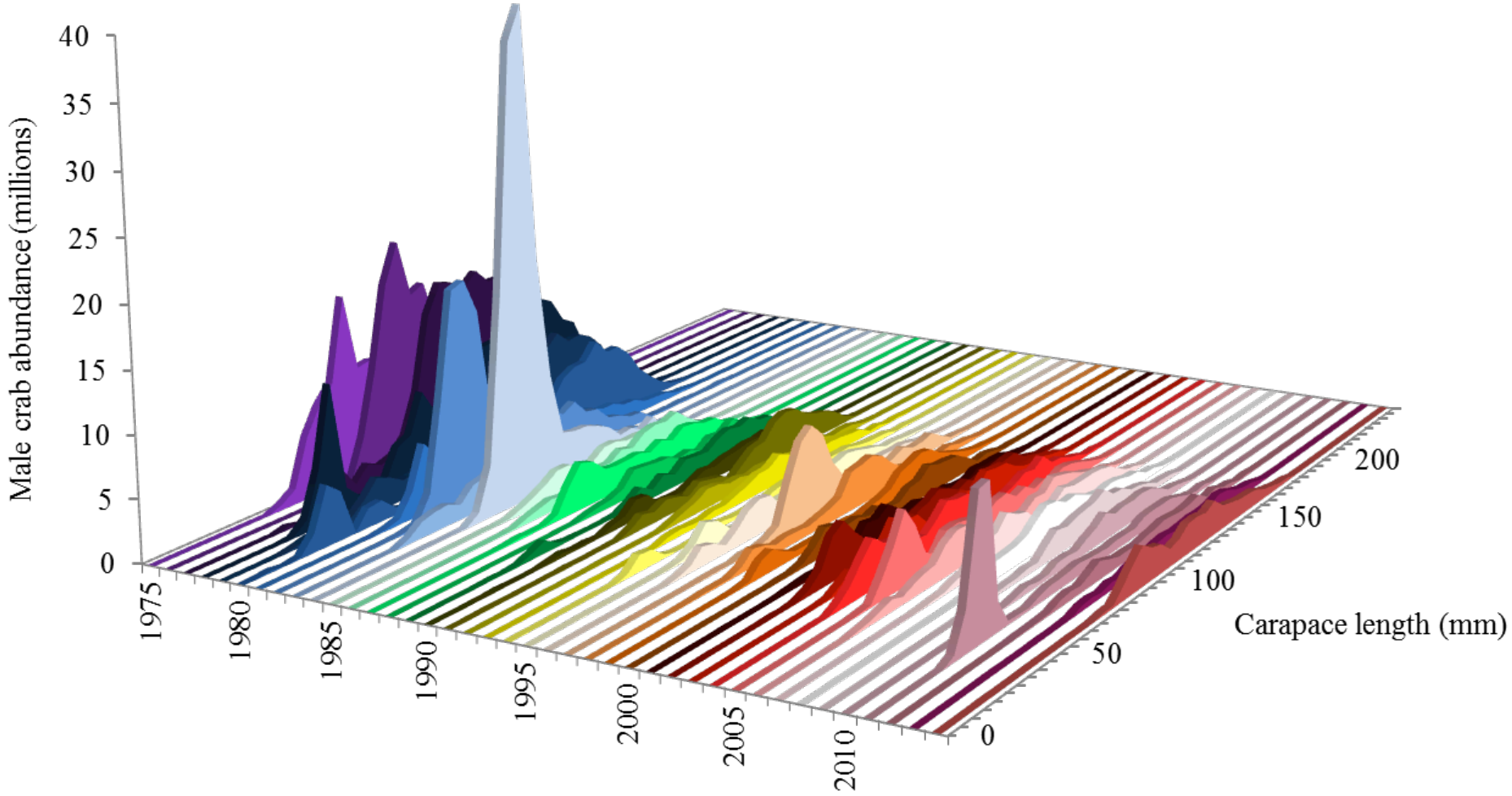



Mature females biomass (t)

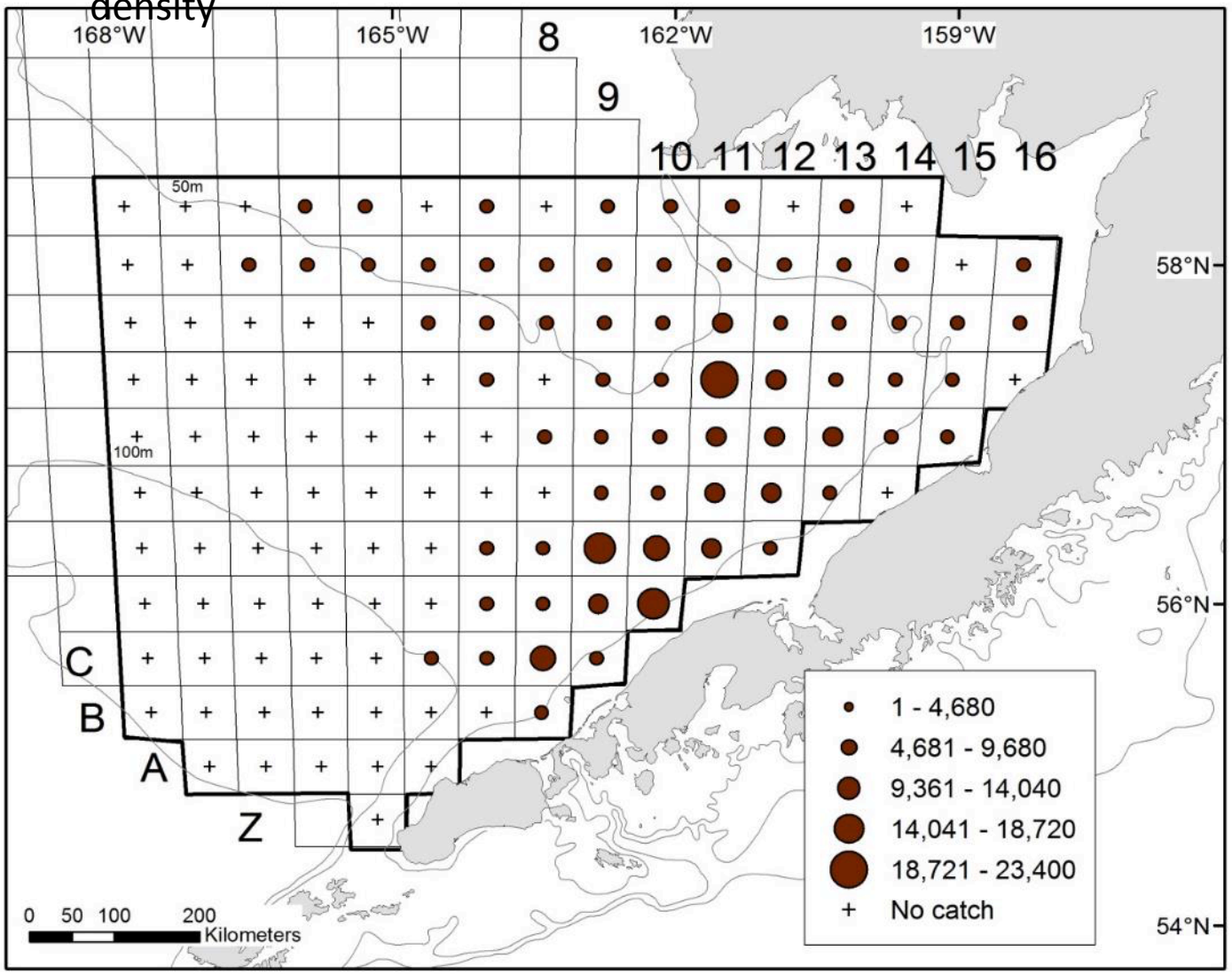



Juvenile abundance (millions)

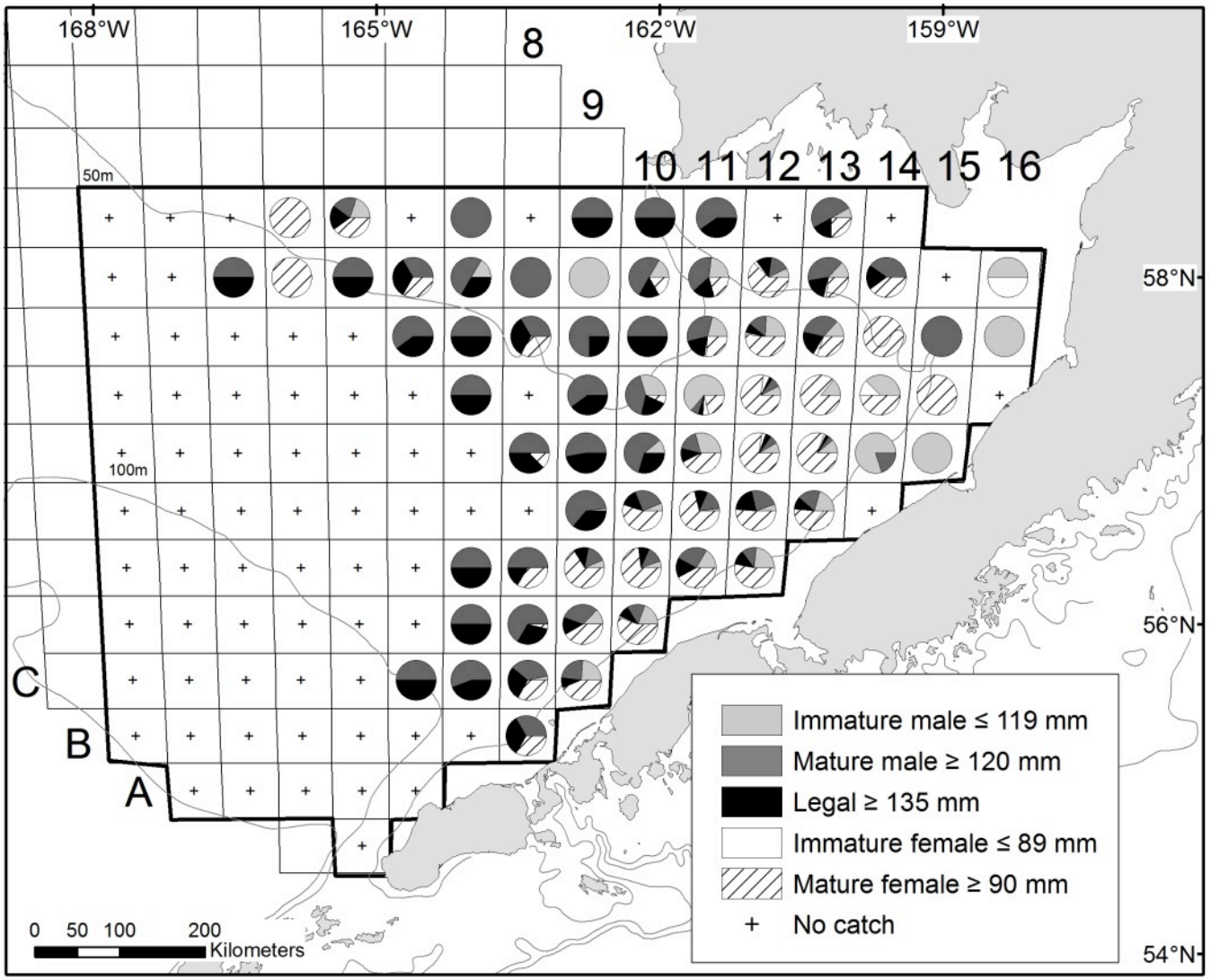
# Bristol Bay Red King Crab



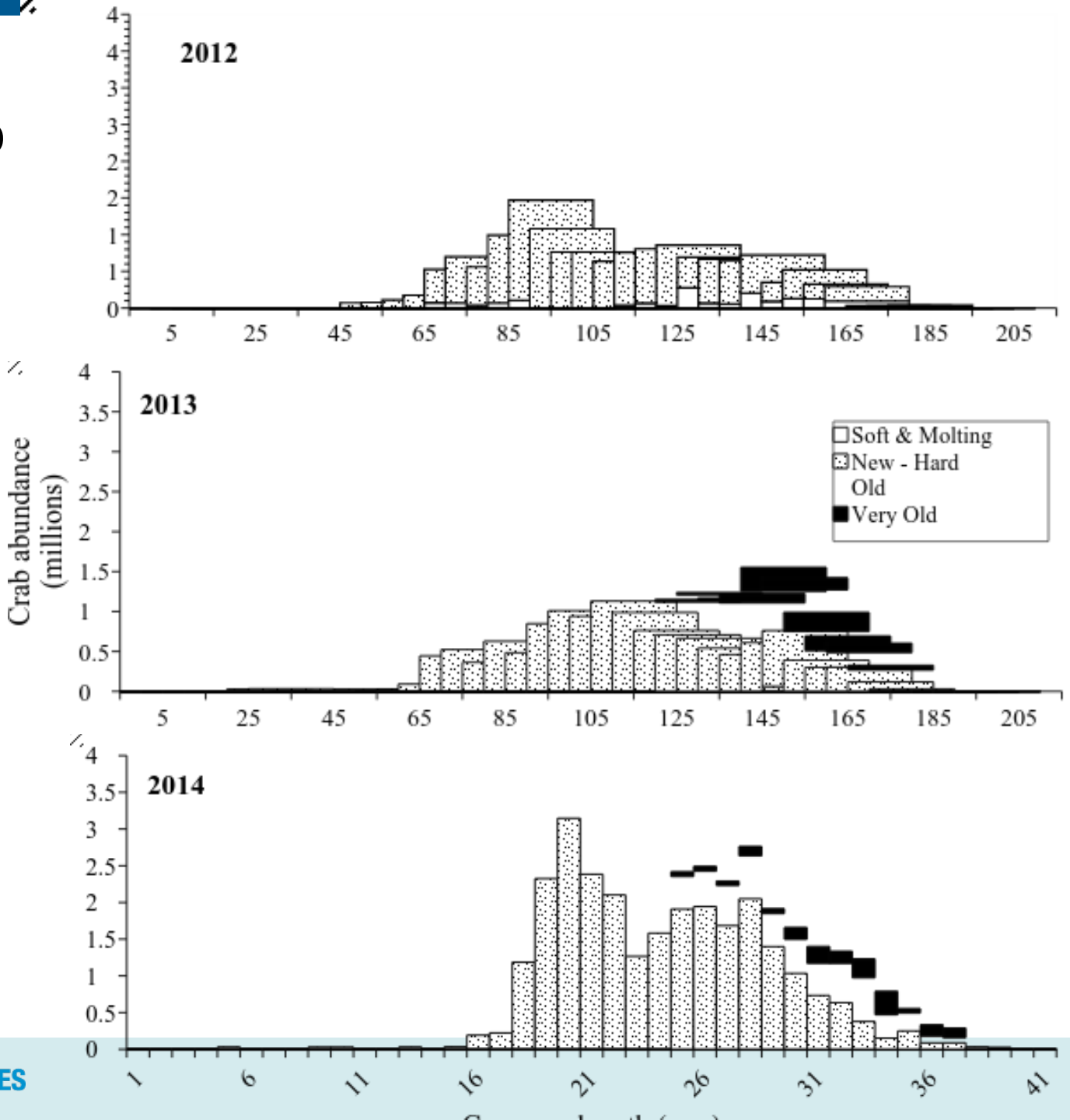
2014 Bristol Bay red king crab (*Paralithodes camtschaticus*) total density



2014 Bristol Bay red king crab (*Paralithodes camtschaticus*)



# Bristol Bay red king crab



New shell

Old shell

Very old shell



From Donaldson and Byersdorfer 2005

| | # tows | #tows with crab | # caught | % | Biomass (t) |
|---|---|---|---|---|---|
| BB RKC | 136 | 57 | 631 | 100 | 47,688 |
| PI RKC | 77 | 4 | 158 | 100 | 12,047 |
| PI BKC | 86 | 2 | 5 | 100 | 233 |
| SM BKC | 56 | 20 | 150 | 100 | 5,472 |
| TC east | 121 | 70 | 2,030 | 94 | 39,910 |
| TC west | 255 | 105 | 3,068 | 86 | 33,394 |
| SC -mature | 376 | 193 | 7,386 | 77 | 105,441 |

*Status and catch specifications (thousand t) for Bristol Bay red king crab*

| Year | MSST | Biomass (MMB) | TAC | Retained Catch | Total Catch | OFL | ABC |
|---|---|---|---|---|---|---|---|
| 2010/11 | 13.63 | 32.64 | 6.73 | 6.76 | 7.71 | 10.66 | |
| 2011/12 | 13.77 | 30.88 | 3.55 | 3.61 | 4.09 | 8.80 | 7.92 |
| 2012/13 | 13.19 | 29.05 | 3.56 | 3.62 | 3.90 | 7.96 | 7.17 |
| 2013/14 | 12.85 | 27.12 | 3.90 | 3.99 | 4.56 | 7.07 | 6.36 |
| 2014/15 | | 24.69 | | | | 6.82 | 6.14 |

# BSAI Crab Additional Assessment

-Bias

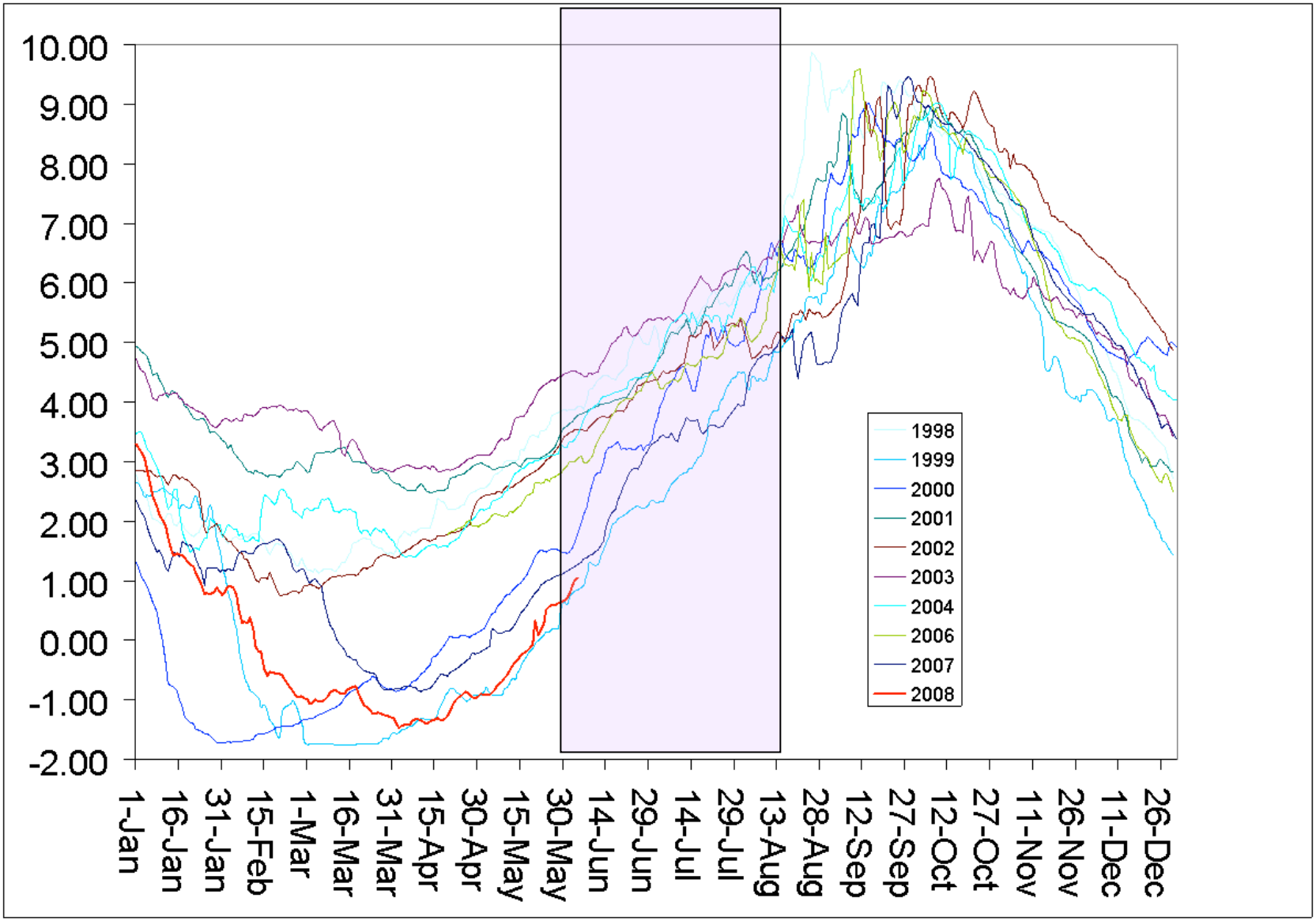
-Availability

-Selectivity

# Bristol Bay Retow for Red King Crab

- 20-35 stations re-towed in cold years
  - Cold: 1999-2000; 2006-2012
  - Warm: 2001-2005; 2013-current
  - Females not completed with molt-mate cycle
  - Unable to assess unmated (barren crab)
  - Females not molted (size frequency data biased)
  - Male abundance similar between leg 1 and retow (leg 3)
  - Female abundance increases in leg 3.

# Daily NBT at 62 meters; Buoy M2

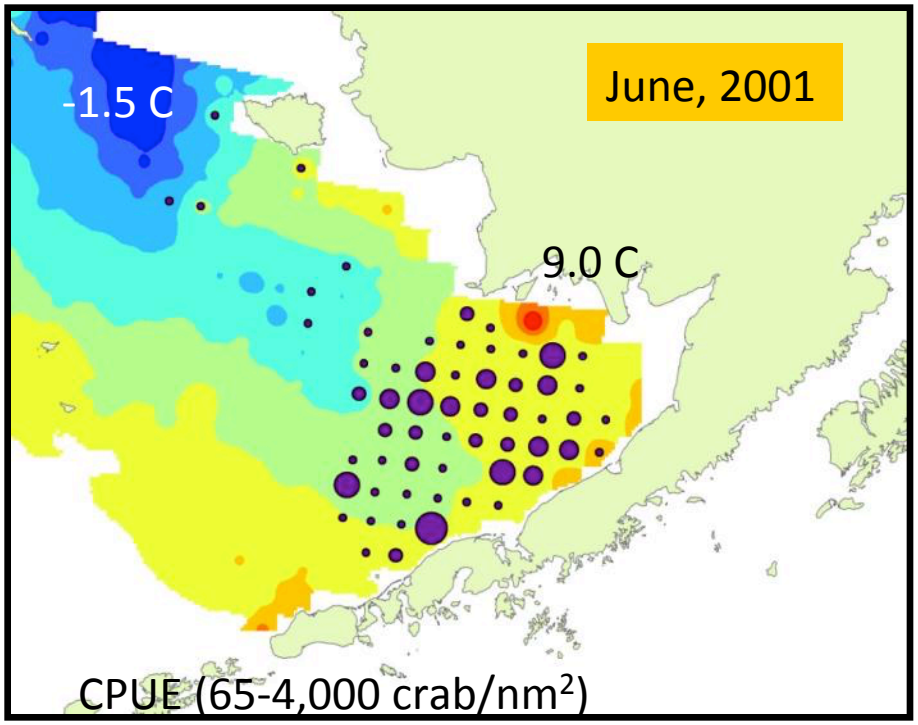


# Embryo Development

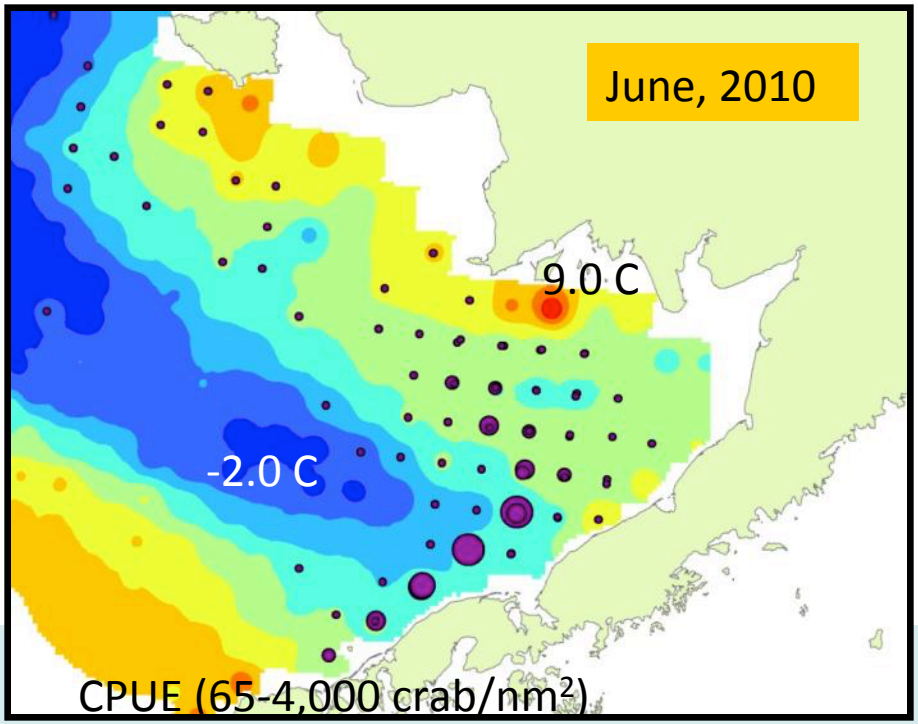
- Uneyed embryos


- Eyed embryos

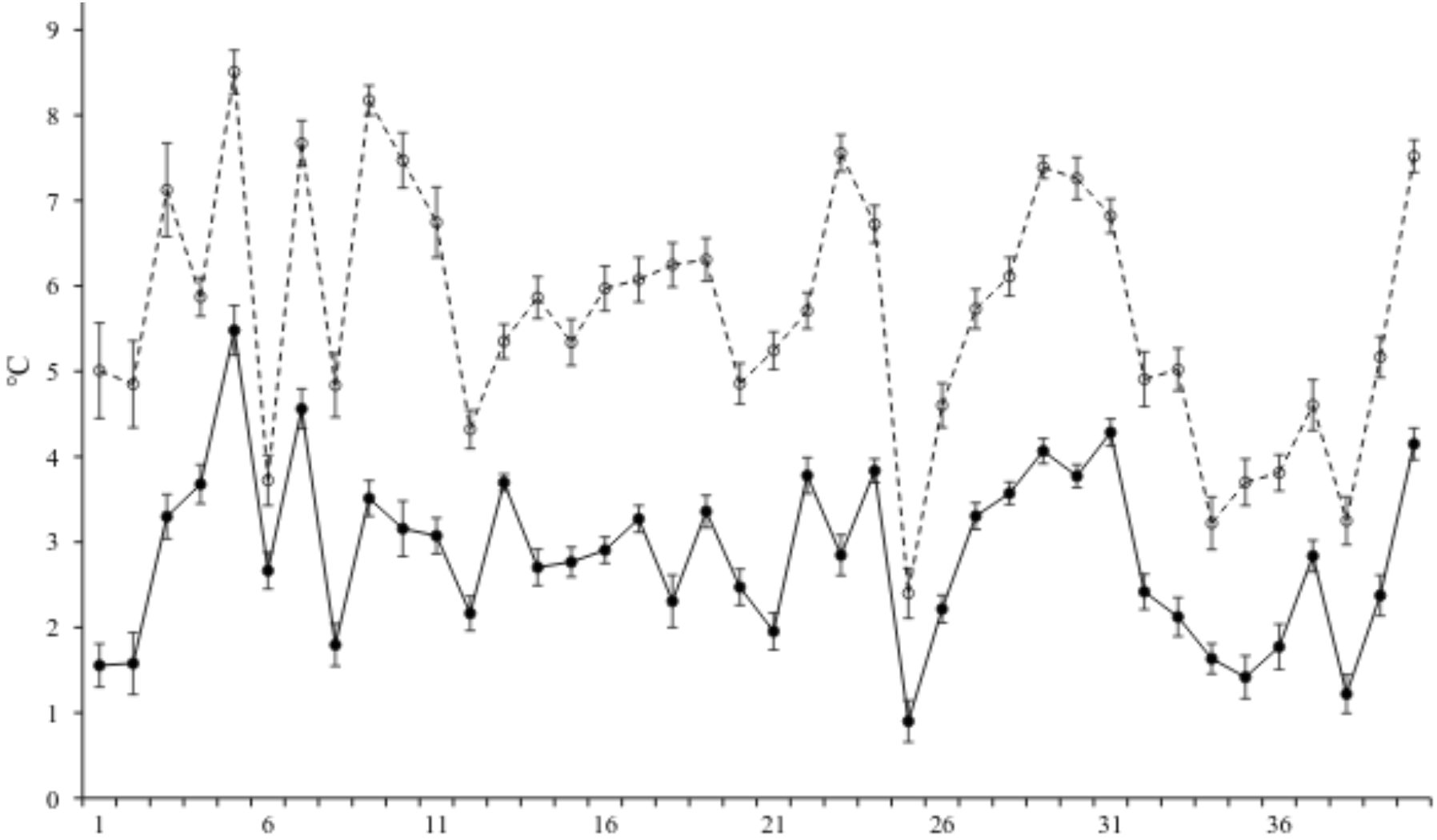
# Bias

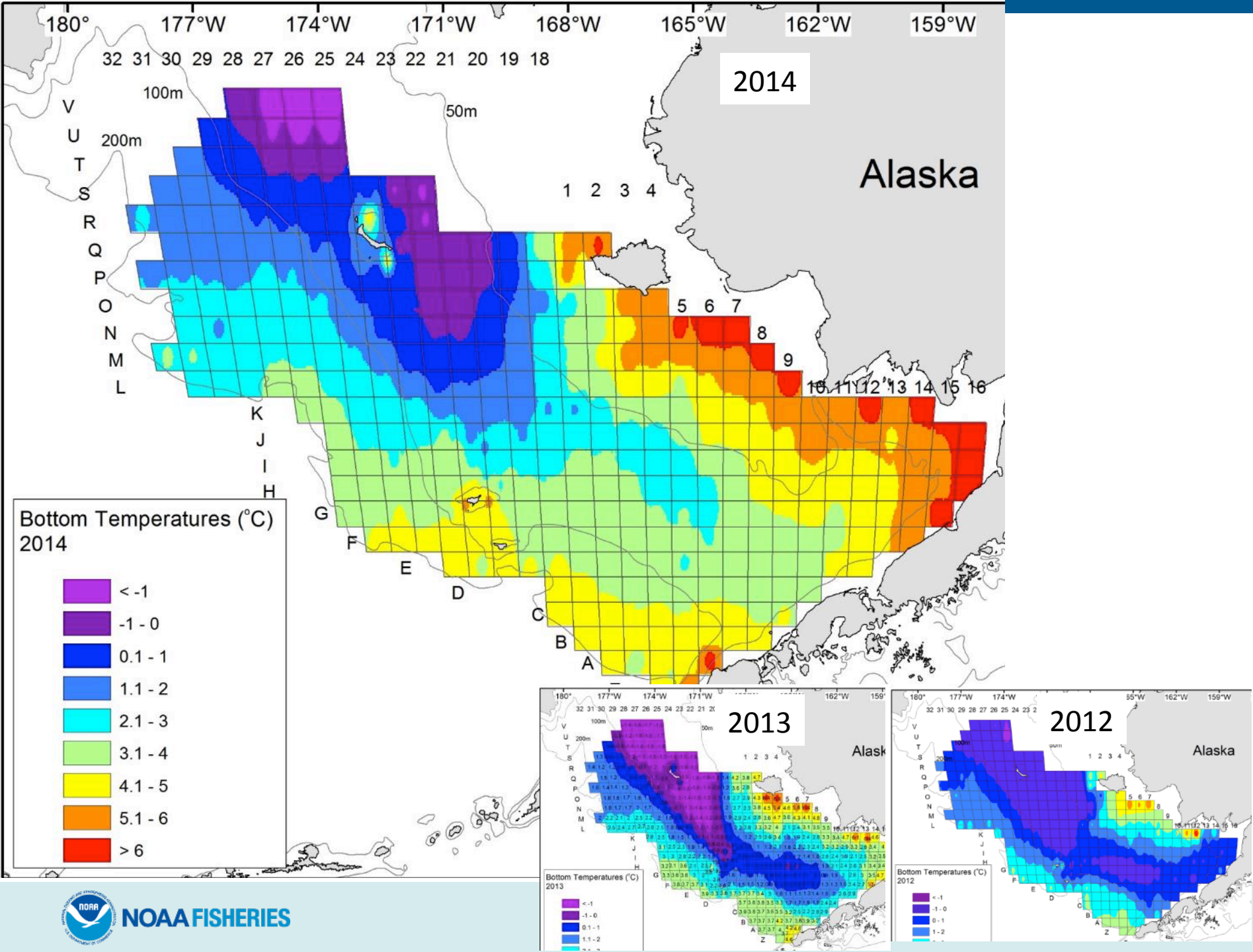



Mature male red king crab



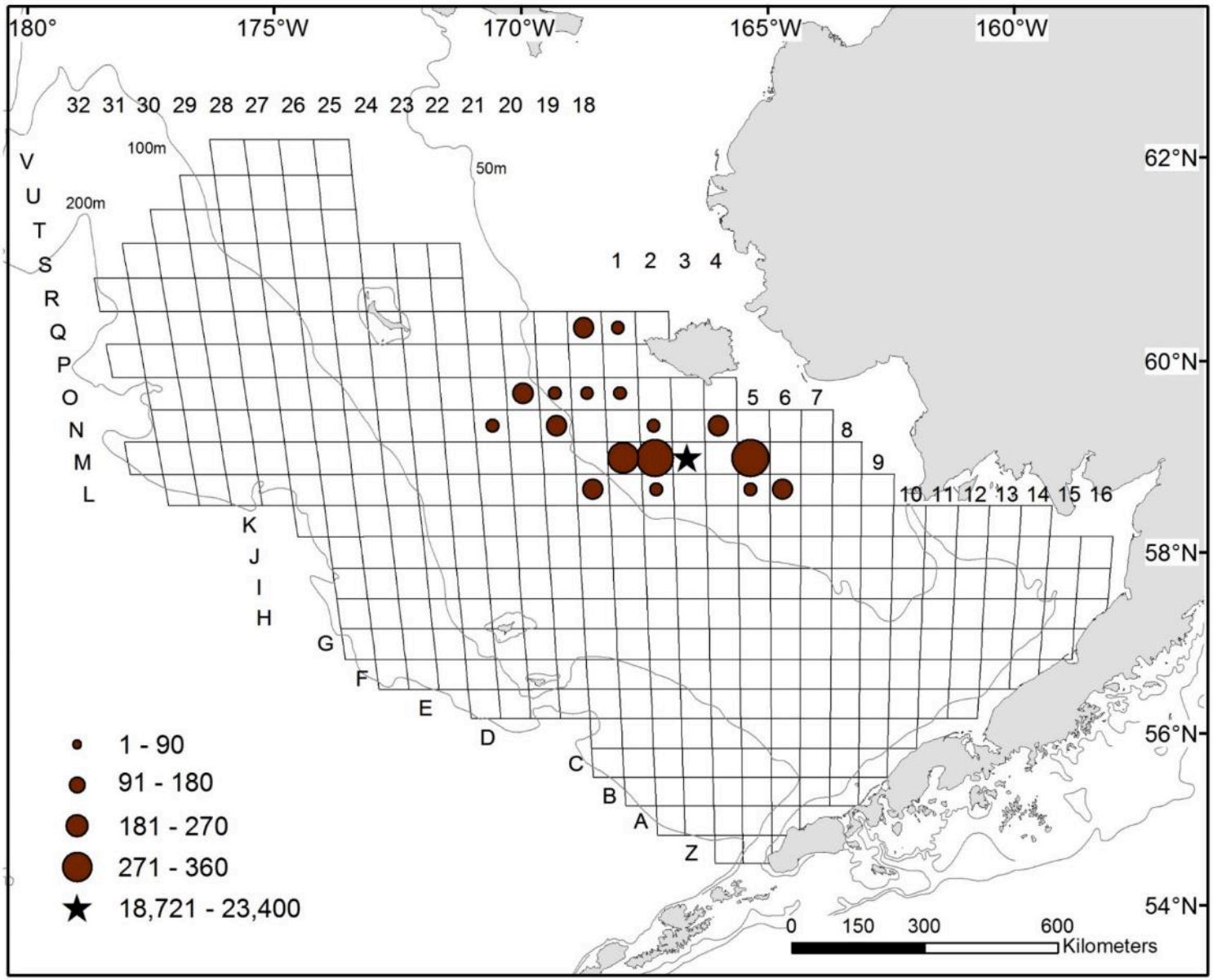
# Bristol Bay Surface (dashed) and Bottom (solid) temperatures




2014
Alaska
180°
177°W
174°W
171°W
168°W
165°W
162°W
159°W
100m
200m
50m
Bottom Temperatures (°C)
2014
< -1
-1 - 0
0.1 - 1
1.1 - 2
2.1 - 3
3.1 - 4
4.1 - 5
5.1 - 6
> 6
2013
2012
NOAA FISHERIES

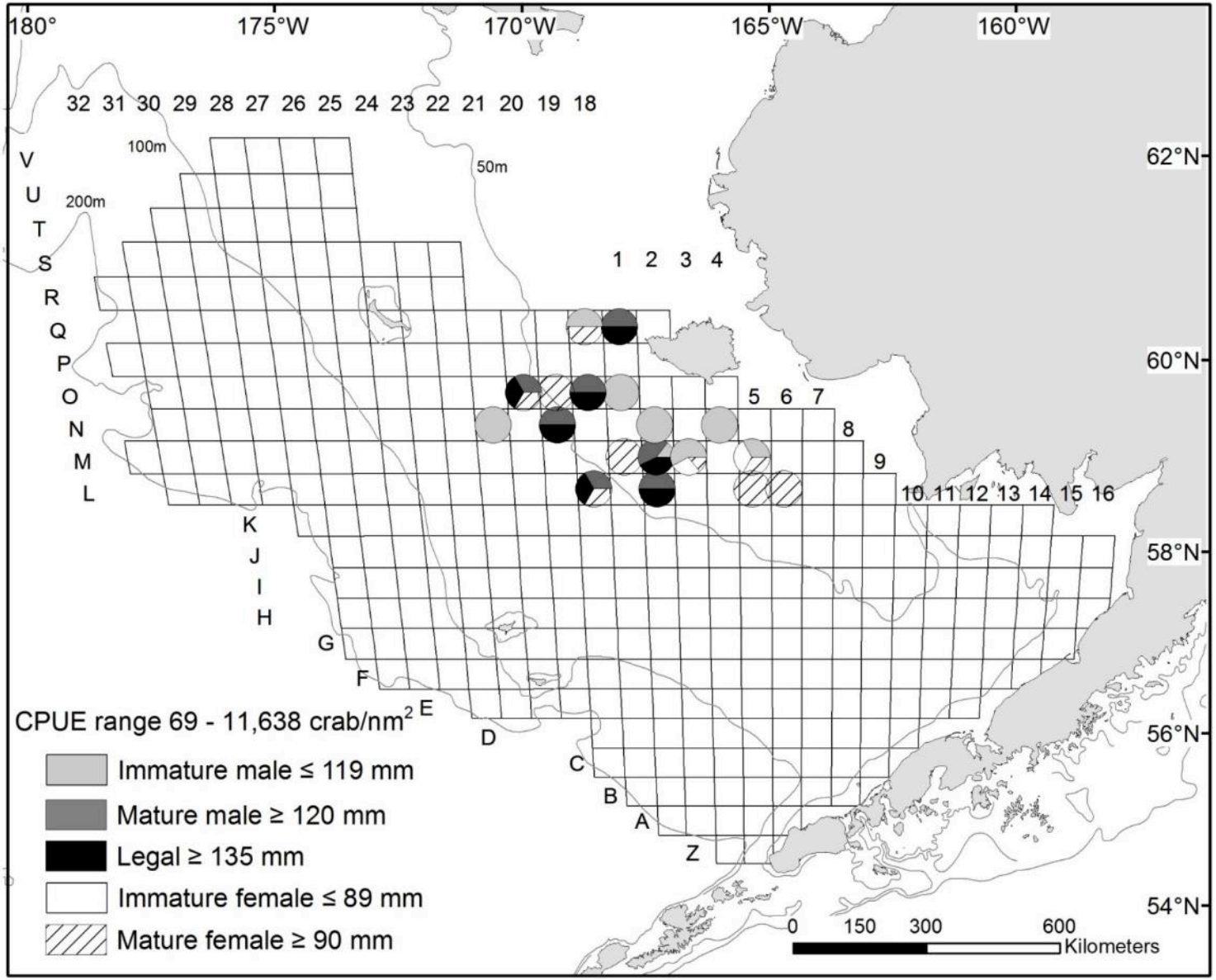
# Availability

Unstratified red king crab (*Paralithodes camtschaticus*)



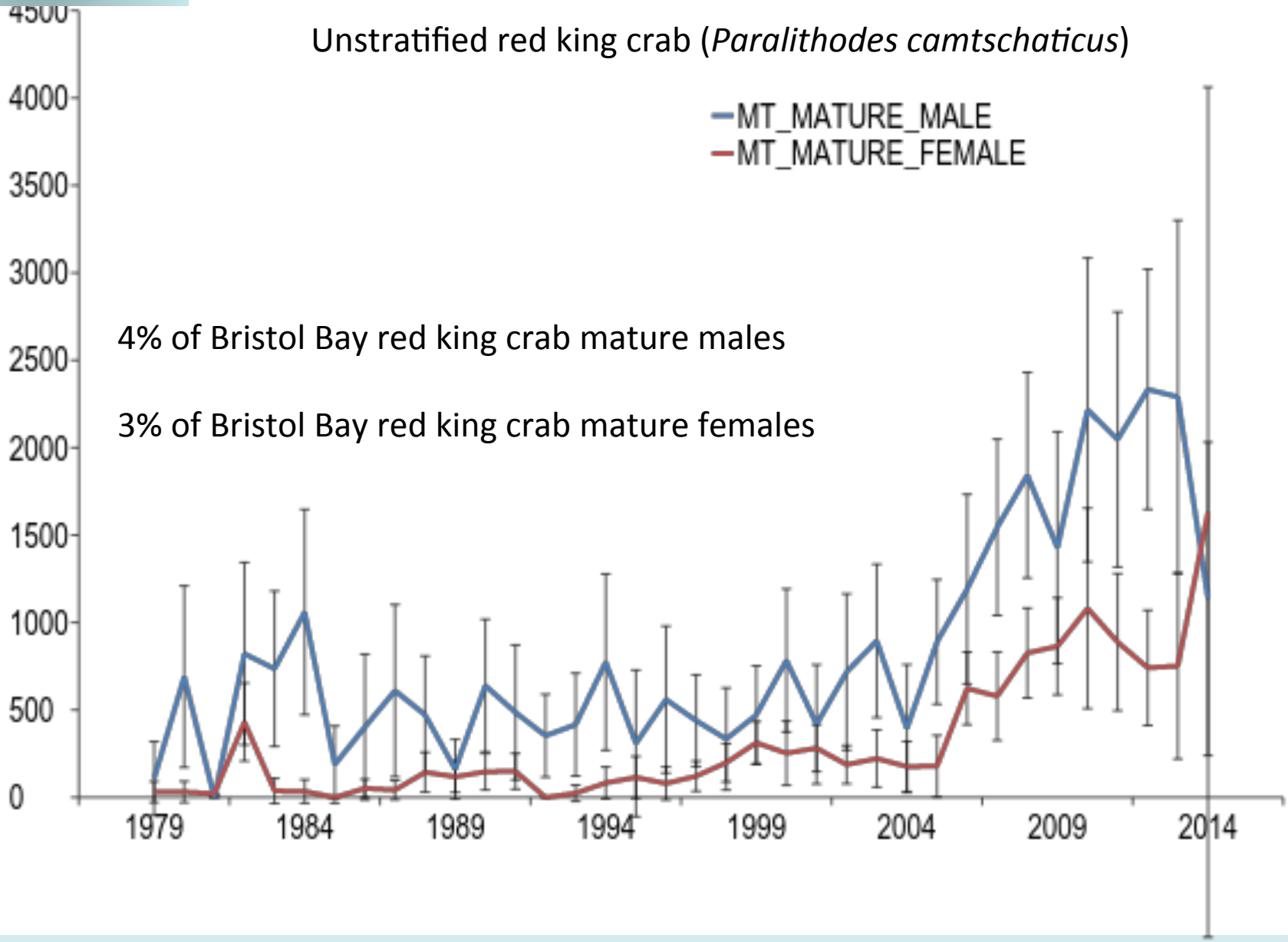
# Availability

Unstratified red king crab (*Paralithodes camtschaticus*)



# Availability

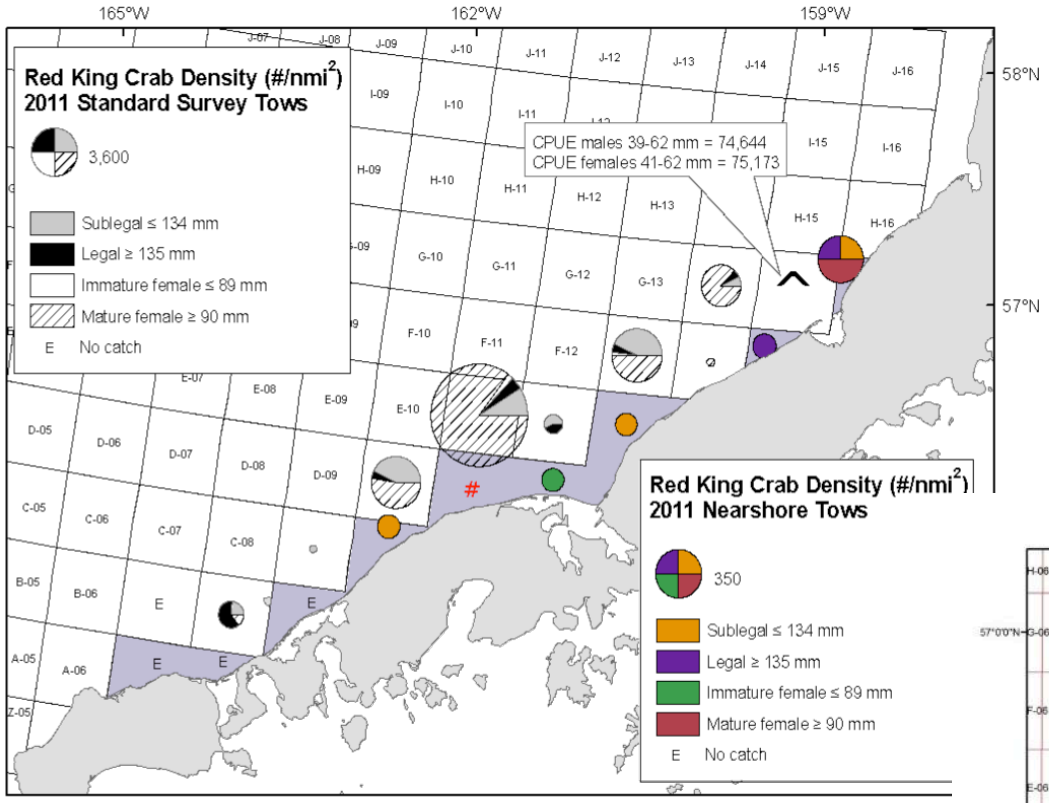
Unstratified red king crab (*Paralithodes camtschaticus*)



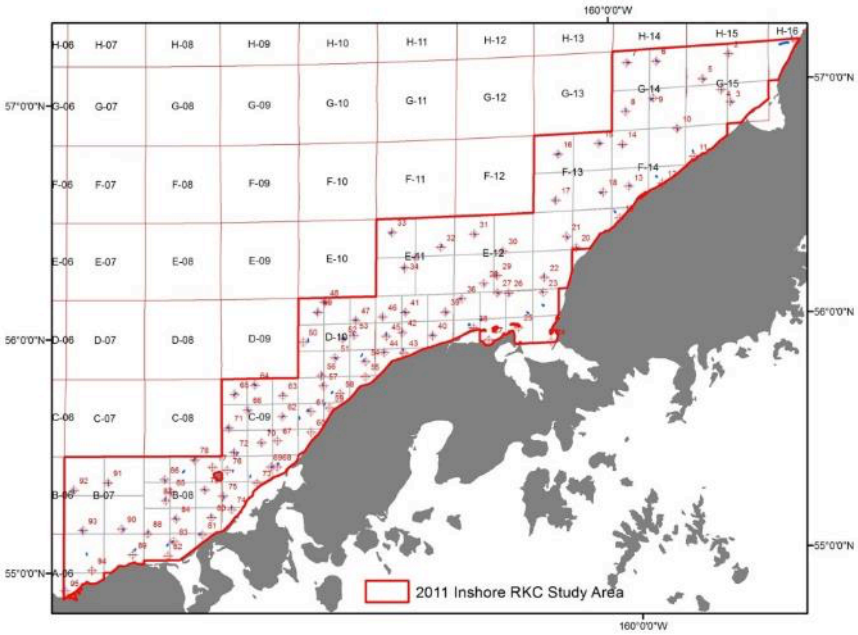

4% of Bristol Bay red king crab mature males

3% of Bristol Bay red king crab mature females

# Bristol Bay RKC standard & nearshore survey

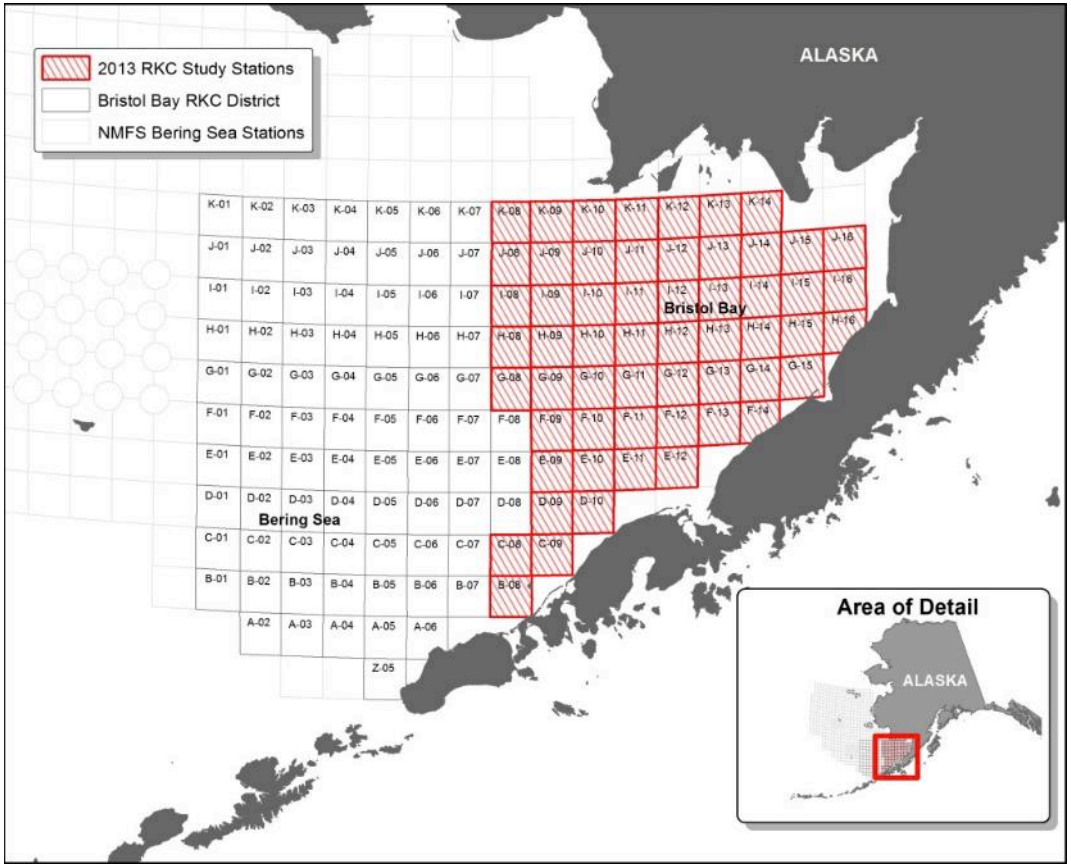



- BSFRF chartered *F/V American Eagle* 2011 and *Half Moon Bay* in 2012
- 2011 results show few crab in nearshore (influenced by warmer inshore area during cold year?)
- 2012 results showed higher densities in inshore area in more severe cold year

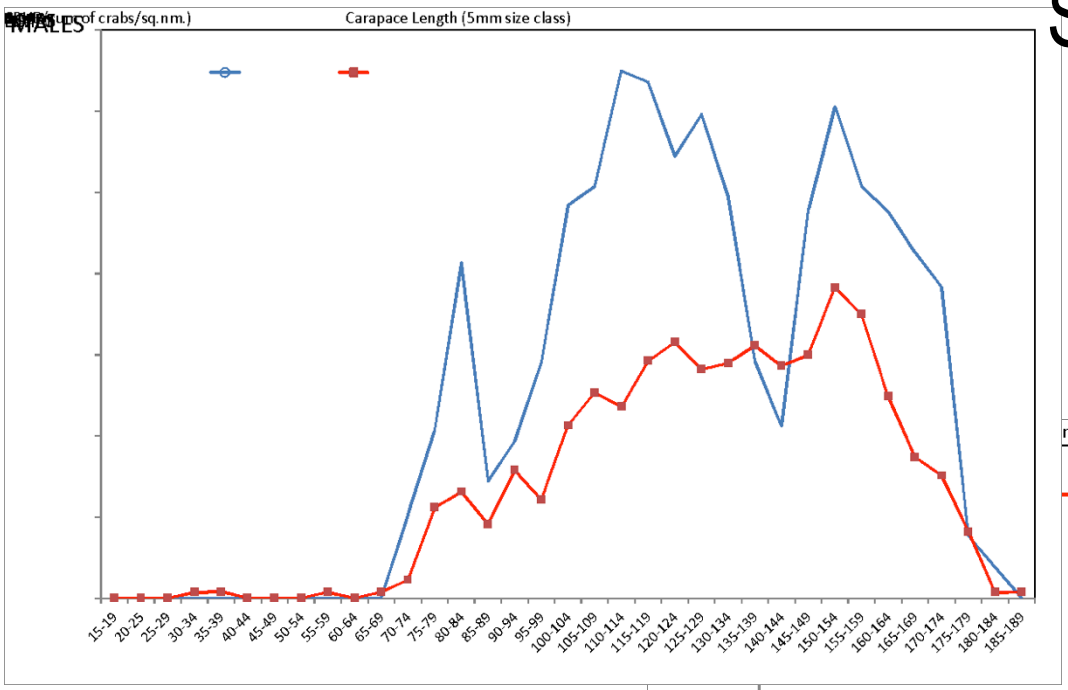


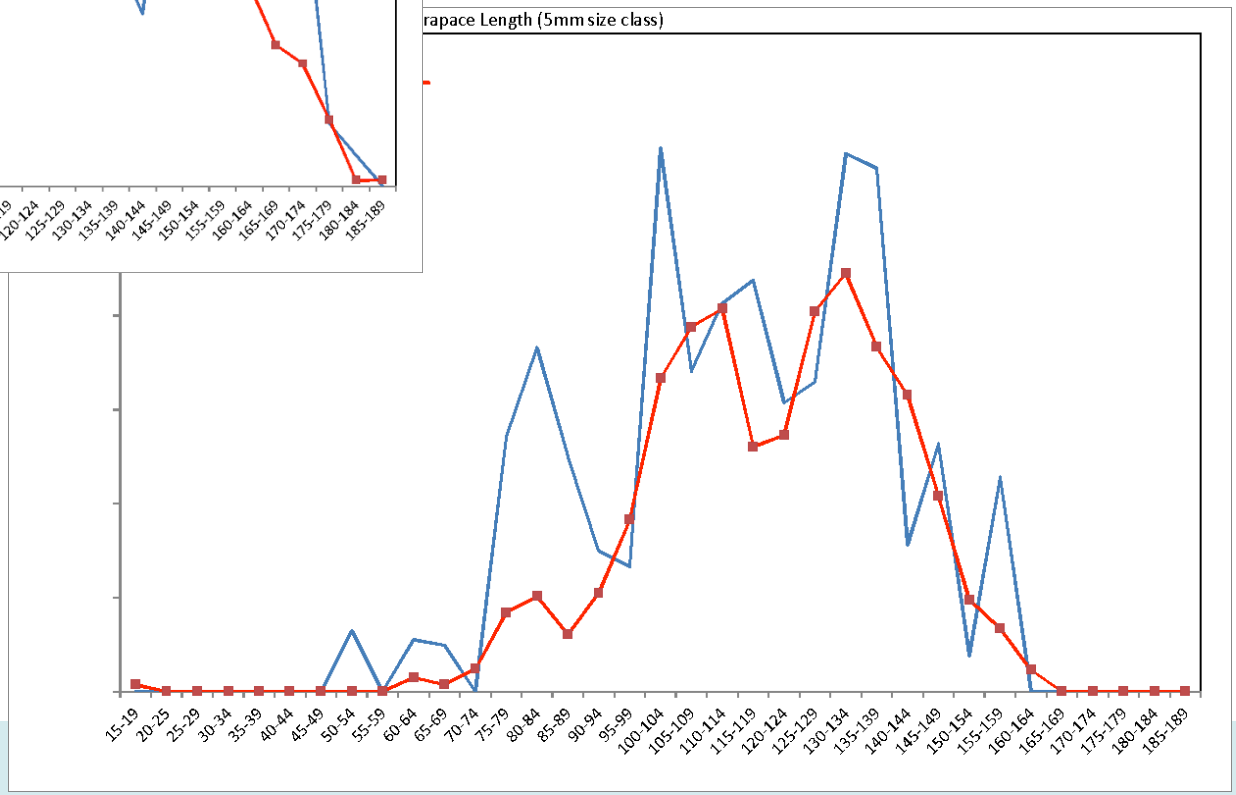
# Cooperative side-by-side surveys

- 2005, 2007
- 2013, 2014, 2015
- Quantify efficiency of NMFS trawl for BBRKC

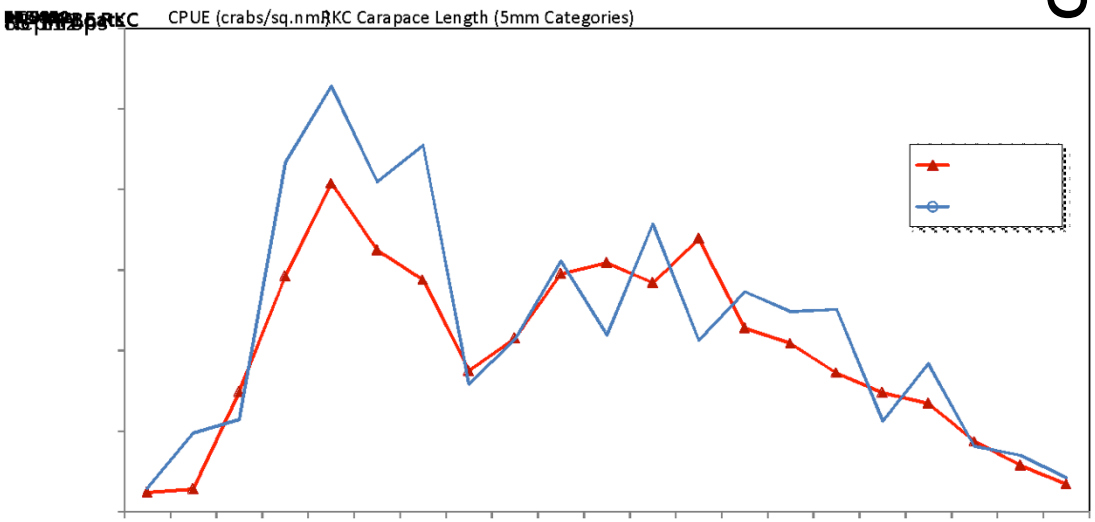


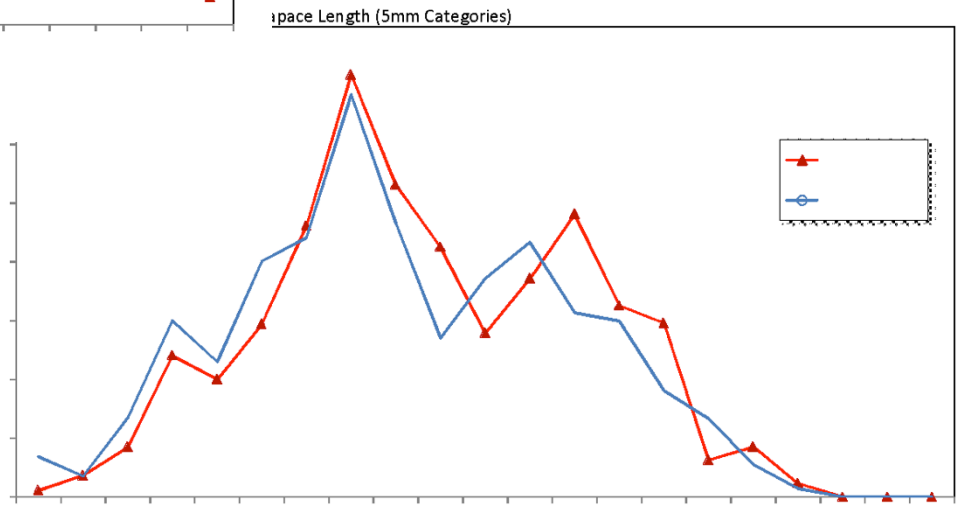
# 2013 Bristol Bay Red King Crab Selectivity Survey



# 2014 Bristol Bay Red King Crab Selectivity Survey



# Thank you